

FINAL
Baseline Monitoring Document and As-Built Baseline Report
Thomas Creek Restoration Project

Wake County, North Carolina

DMS Project ID No. 96074, DEQ Contract No. 5549

Permits: SAW-2013-02009, DWR#14-1328

Cape Fear River Basin: 03030004-020010



Prepared for:

NC Department of Environmental Quality
Division of Mitigation Services (DMS)
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

Data Collection Period: October-November 2015

Submission Date: October 2016



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1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 4,721 linear feet (LF) of perennial and intermittent stream and enhanced 3,948 LF of intermittent stream. Baker also planted approximately 14 acres (AC) of native riparian vegetation within the 22.7 acre recorded conservation easement areas along all or portions of the restored and enhanced reaches (Reaches R1, R2, R3, R4, R5, R6, R7, T1, and T2). The Thomas Creek Restoration Project (Site) is located in Wake County, North Carolina (Figure 1), approximately 1.5 miles southwest of the Community of New Hill. (Figure 1). The Site is located within the NC Division of Mitigation Services' (NCDMS) Targeted Local Watershed (TLW) 03030004-020010 (the Harris Lake HU) of the Cape Fear River Basin, and is located in what was formerly known as the NC Division of Water Resources (NCDWR) subbasin 03-06-07. The project involved the restoration and enhancement of a Rural Piedmont Stream (Schafale and Weakley 1990) which had been impaired due to past agricultural conversion and cattle grazing.

Based on the NCDMS 2009 Cape Fear River Basin Restoration Priority (RBRP) Plan, the Thomas Creek Restoration Project area is located in an existing targeted local watershed within the Cape Fear River Basin and is located within the Middle Cape Fear / Kenneth and Parker Creeks, Local Watershed Planning (LWP) area. The restoration strategy for the Cape Fear River Basin is to promote low impact development, stormwater management, restoration and buffer protection in urbanizing areas, and buffer preservation elsewhere.

The primary goals of the project were to improve ecologic functions through the restoration and enhancement of streams and buffers in a degraded, urbanizing area as described in the NCDMS 2009 Cape Fear RBRP, and are identified below

- Create geomorphically stable conditions along the unnamed tributaries throughout the Site,
- Protect and improve water quality by reducing streambank erosion, and nutrient/sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes,
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement, and
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Implement agricultural BMPs, including cattle watering stations, to reduce nonpoint source (NPS) inputs to receiving waters,
- Prevent cattle from accessing the conservation easement by installing permanent fencing and thus reduce excessive streambank erosion and undesired nutrient inputs,
- Enhance aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated streambank erosion,
- Plant native species riparian buffer vegetation along streambank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve streambank stability and riparian habitat connectivity, and shade the stream to decrease water temperature, and

- Control invasive species vegetation within much of the project area and, if necessary, continue treatments during the monitoring period.

This report documents the completion of the restoration and enhancement construction activities and presents as-built monitoring data for the post-construction monitoring period. Table 1 summarizes project conditions before and after restoration and enhancement, as well as the conditions predicted in the previously approved project Mitigation Plan. Table 1 is located in Appendix A.

2.0 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

2.1 Project Location and Description

The Site is located in Wake County, NC, approximately 1.5 miles southwest of the community of New Hill, as shown on the Vicinity Map (Figure 1). The Site is located in the NCDMS TLW 03030004-020010 (the Harris Lake HU) of the Cape Fear River Basin, and is located in what was formerly known as NCDWR subbasin 03-06-07. The project includes nine unnamed headwater tributaries (UTs) to Thomas Creek and is located in the Piedmont physiographic region. The UTs were divided into individual Reaches (R1, R2, R3, R4, R5, R6, R7, T1 and T2) as shown in Figure 2.

Project Reaches R1, R2, R3, R4, and T1 are shown as dashed blue-line streams on the USGS topographic quadrangle map. Project Reaches R5, R6, R7, and T2 are not shown as blue-line streams, dashed or solid. Reaches R1, R2, R3, and R4 are listed as perennial streams within the project limits on the 1970 Wake County Soil Survey. The remaining reaches are all shown in the Soil Survey maps and are listed as intermittent, unclassified streams. The presence of historic valleys for each of the project stream systems is clearly evident on LIDAR imagery. On-site jurisdictional field determinations for the project identified Reaches R1, R2, R3 (downstream), R4, R5, R6 (downstream), and R7 (downstream) as perennial, while Reaches R3 (upstream), R6 (upstream), R7 (upstream), T1, and T2 were identified as intermittent. These determinations were confirmed during field investigations and on-site jurisdictional determination with the United States Army Corps of Engineers (USACE), NCDWR and NCDMS. The preliminary jurisdictional determination was approved in September 2014.

Based on the NCDMS 2009 Cape Fear RBRP plan, the Thomas Creek Restoration Project area is located in an existing TLW within the Cape Fear River Basin (2009 Cape Fear RBRP), and is located within the Middle Cape Fear / Kenneth and Parker Creeks LWP area. The restoration strategy as stated in the RBRP for the Cape Fear 03030004 8-digit Catalog Unit (CU) is to promote low impact development, stormwater management, restoration and buffer protection in urbanizing areas, and buffer preservation elsewhere.

Site Directions

To access the Site from Raleigh, take US-1 south and head south towards Sanford, for approximately 12 miles. Take the ramp for Exit 89 to New Hill/Jordan Lake. At the end of the ramp turn right on New Hill-Holleman Road and continue for 0.8 miles to the stop sign at Old US Highway 1. Turn left on Old US Highway 1 and continue 1.1 miles before turning left on Shearon Harris Rd (SR1134). The destination will be on the right in 0.4 miles. Turn right onto the gravel road and continue to the end to park among the most southern farm buildings. The site is to the southwest and west.

2.2 Project Goals and Objectives

The primary goals of the project are to improve ecologic functions and to manage NPS inputs to the impaired areas as described in the NCDMS 2009 Cape Fear RBRP and are identified below:

- Create geomorphically stable conditions along the unnamed tributaries throughout the Site,
- Protect and improve water quality by reducing streambank erosion, and nutrient/sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes,
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement, and

- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Implement agricultural BMPs, including cattle watering stations, to reduce NPS inputs to receiving waters,
- Prevent cattle from accessing the conservation easement by installing permanent fencing and thus reduce excessive streambank erosion and undesired nutrient inputs,
- Enhance aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated streambank erosion,
- Plant native species riparian buffer vegetation along streambank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve streambank stability and riparian habitat connectivity, and shade the stream to decrease water temperature, and
- Control invasive species vegetation within much of the project area and, if necessary, continue treatments during the monitoring period.

3.0 PROJECT STRUCTURE, RESTORATION TYPE AND APPROACH

3.1 Project Components

The project area consists of the restoration and enhancement of nine UTs to Thomas Creek and is located in the Piedmont physiographic region. For assessment and design purposes, the nine UTs were divided into individual Reaches (R1, R2, R3, R4, R5, R6, R7, T1 and T2). Native species riparian buffer vegetation was established and/or protected at least 50 feet from the top of both bank along all project reaches. Lastly, cattle were excluded along project reaches R1, R2, R3, R4, R5, and T1 through permanent fencing outside of the conservation easement. The reach designations have remained in the same order to be consistent throughout the document.

3.2 Restoration Approach

Based on the post-construction as-built survey, the project consisted of 298 LF of Restoration on Reach R1, 2,126 LF of Restoration on Reach R2, 914 LF of Restoration on Reach R3 (downstream), 117 LF of Enhancement II on Reach R3 (upstream), 342 LF of Restoration on Reach R4 (downstream), 896 LF of Enhancement II on Reach R4 (upstream), 1,041 LF of Restoration on Reach R5 (downstream), 128 LF of Enhancement II on Reach R5 (upstream), 1,566 LF of Enhancement II on Reach R6 (downstream), 210 LF of Enhancement I on Reach R6 (upstream), 287 LF of Enhancement II on Reach R7 (downstream), 360 LF of Enhancement II on Reach R7 (upstream), 227 LF of Enhancement I on Reach T1, and 157 LF of Enhancement II on Reach T2. Table 1 and Figure 2 (Appendix A) provide a summary of the project components. A recorded conservation easement consisting of 22.7 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity.

The project involved the restoration and enhancement of a Rural Piedmont Stream System (Schafale and Weakley 1990) which had been impaired due to past agricultural conversion and cattle grazing. Restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain, and restoring natural flows to areas previously drained by ditching activities. The existing channels abandoned within the restoration areas were partially to completely filled to decrease surface and subsurface drainage and raise the local water table. Permanent cattle exclusion fencing was installed around all proposed reaches and riparian buffers, where cattle have access (R1, R2, R4 upper, R5 lower, T1 and T2).

The vegetative components of this project included stream bank, floodplain, and transitional upland planting and is described as the riparian buffer zone. The Site was planted with native species riparian buffer vegetation as shown in Table 7 and Table 8 (Appendix C) and now protected through a permanent conservation easement.

3.2.1 Reach R1 Restoration

Reach R1 was significantly incised and degraded with actively eroding banks, and had downcut to a large existing bedrock feature in the downstream portion of the Reach. A Priority Level II restoration approach was chosen for this Reach that transitioned the restored channel back to the existing grade within approximately 250 feet of the downstream extent of the project.

The restored channel was constructed as a Rosgen 'C5' stream type. In-stream structures such as constructed riffles were installed to control grade, dissipate scour energies, and eliminate the potential for upstream channel incision. Additionally, log vanes and weirs were incorporated for scour formation, bank stability, and habitat diversity.

The width/depth ratio for this reach is 17.4 at Cross Section 12, and over time, the channel may narrow due to deposition of sediment and streambank vegetation growth. Channel narrowing should not risk

downcutting because any narrowing would be in response to stabilizing processes (i.e., tree establishment, point bar formation). The bankfull floodplain bench will provide energy dissipation when needed to maintain channel stability.

Channel banks were graded to stable, 2:1 or flatter slopes wherever possible, bankfull benches were incorporated along most of the Reach to further promote stability, and riparian vegetation was re-established throughout the buffer.

Riparian buffers in excess of 50 feet were restored along all of Reach R1, and invasive species treatment was conducted throughout the reach. No stream crossing or breaks in the easement were installed along this reach. Fencing was installed along R1 to exclude cattle from the easement area.

3.2.2 Reach R2 Restoration

Work along Reach R2 involved a combination of Priority Level I and II restoration approaches to provide floodplain reconnection and promote long-term channel stability. Before construction, R2 was incised and eroding throughout its length. Mature hardwood trees were abundant for the first 600 feet of existing channel, after which the channel enters open pasture and was against the right side of the valley for 1,300 feet.

To preserve the existing mature canopy as much as possible and to improve the floodplain width of a stabilizing channel, a Priority Level II restoration was selected for the upstream portion of Reach R2. This upper section was built as a Rosgen 'C5' stream type. In the location of Cross Section 5 the width/depth ratio is 14.8 and the entrenchment ratio is 3.7. Bankfull benches were excavated throughout most of this upper section to promote stability.

Where Reach R2 entered the channelized section that flowed through pasture, Priority Level I, restoration was implemented. This reach was also built as a Rosgen 'C5' stream type. Cross Section 6 shows that this reach has a width/depth ratio of 10.08. While this is width/depth ratio is lower than the standard width/depth ratio of 12 for a 'C' stream type, the channel still fits within a 'C' stream type using the continuum of physical variables that allow some fluctuation on parameter values. The channel sinuosity is also more in line with a 'C' stream type. The bankfull floodplain will provide energy dissipation for storm discharges greater than the bankfull discharge to maintain channel stability.

These approaches allow for the restoration of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, exclusion of cattle and associated pollutants, and decreased erosion and sediment loss from streambank erosion.

Mapped jurisdictional wetlands in the lower Reach R2 floodplain were protected during the construction process. Wetland enhancement was achieved by raising the streambed and thus elevating the local water table and hydroperiod. Additionally, wetland vegetation was reestablished and protected. Numerous vernal pools were also incorporated along the filled abandoned channel in the right floodplain to provide additional habitat diversity and improved floodwater detention.

Riparian buffers in excess of 50 feet were restored along all of Reach R2, and invasive species treatment was conducted throughout the reach. One gated stream crossing was installed within a break in the easement along Reach R2, at the transition from Priority Level II to Priority Level I. Fencing was installed along R2 to exclude cattle from the easement area.

3.2.3 Reach R3 Restoration and Enhancement

After an initial 117-foot section of Level II Enhancement (invasive species treatment and some supplemental buffer planting only), work along Reach R3 involved a combination of Priority Level I and II restoration approaches to provide floodplain reconnection and promote long-term channel stability. In its existing condition, the reach was incised and actively eroding. These techniques

allowed for the restoration of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, and decreased sedimentation from streambank erosion. This reach was constructed with a meandering riffle/pool bedform morphology, which has led to a stable longitudinal profile and diverse microhabitat for aquatic organisms. The reach was constructed as a Rosgen 'C5' stream type.

Much of the mapped jurisdictional wetlands in the upper Reach R3 floodplain were protected during the construction process. Wetland enhancement was achieved for the entire reach by raising the streambed and thus elevating the local water table as well as increasing the hydroperiod. Additionally, wetland vegetation was reestablished.

Riparian buffers in excess of 50 feet were restored along all of Reach R3, and invasive species treatment was conducted throughout. One existing stream ford crossing location in the lower section of R3 was maintained within an easement break, but was improved to a pipe crossing. Cattle are excluded and do not have access to this crossing.

3.2.4 Reach R4 Restoration and Enhancement

Work on the lower portion of Reach R4 involved a restoration approach along the 342-foot section of the downstream end to its confluence with Reach R3.

The primary source of impairment for Reach R4 was incision caused by a headcut that had migrated up from Reach R2. The existing ford crossing stopped the migration of the headcut, and consequently, the upper portion of Reach R4 immediately upstream of the crossing is highly stable and has been used as a reference reach. The upper 870-foot section of Reach R4 was included as an Enhancement Level II reach. The riparian buffers were largely adequate but the outer portion of the left bank buffer was in pasture so it was planted to make it at least 50 feet wide. The existing fence along this left bank, where cows had access to the pasture, was replaced and relocated farther out to enclose this planted buffer. Per agreement with the Interagency Review Team (IRT), invasive species control was not conducted for upper Reach R4.

Along the downstream end of Reach R4, the channel was in poor condition due to incision. This reach section was restored using Priority Level II restoration and used log jams and constructed riffles to control grade, dissipate energies, and eliminate the potential for upstream channel incision. Channel banks were graded to stable slopes, and bioengineering measures were incorporated to further promote stability and re-establish riparian vegetation. This section of Reach R4 was constructed as a Rosgen 'C5' stream type. In the location of Cross Section 4, the width/depth ratio is 12.7 and floodplain benches were excavated to increase the active floodplain width, which reduce stresses on the restored channel during out of bank storm events.

Riparian buffers in excess of 50 feet were restored along all of Reach R4 and invasive species treatment was conducted throughout lower R4. One existing stream ford crossing located at the break between the upper and lower portions of R4 was maintained within an easement break, but was improved to a gated pipe crossing. Old fencing was removed and replaced along the eastern boundary of the downstream section of R4 to exclude cattle from the easement area. Additionally, a small vehicular bridge located at Station 12+40 was removed.

3.2.5 Reach R5 Restoration and Enhancement

Work on Reach R5 continued the enhancement approach (easement establishment, invasive species treatment, and supplemental planting) from lower Reaches R6 and R7. This work extended to the top 128 feet of Reach R5, at which point the approach switched to Priority Level I restoration, beginning at an active headcut. The first 300 feet of the Priority I section was within a forested area, while the lower 700 feet was in active pasture. The benefits of this approach included floodplain reconnection,

and a full restoration of a natural channel dimension, pattern, and profile, which improve natural stream functions.

Lower Reach R5 was designed as a Rosgen 'C5' stream type. The width/depth ratio at Cross Section 14 is 8.38 which makes this an 'E' stream type. This should not cause any negative issues as this is a small channel and has already established herbaceous vegetation and livestock, which will help to prevent bank erosion. The as-built width/depth ratio at this location is similar to reference reach streams in this area. Log structures were installed to maintain pools and provide grade control. The new channel was constructed primarily off-line from the existing channel. Existing mature, native trees were preserved wherever possible. At the downstream end of the reach, floodplain benching was installed near the confluence with Reach R2, to tie into the benching constructed for that reach and Reach R1.

Mapped jurisdictional wetlands in the upper Reach R5 floodplain were enhanced by raising the streambed and thus elevating the local water table as well as increasing the hydroperiod. Additionally, wetland vegetation was reestablished. Numerous vernal pools were also incorporated along the filled abandoned channel in the floodplain of Reach R5 to provide additional habitat diversity and improved floodwater detention.

Riparian buffers in excess of 50 feet were restored along all of Reach R5, and invasive species treatment was conducted throughout. The existing stream crossing near the downstream end of Reach R5 was relocated upstream within an easement break and was improved. Fencing was installed along the downstream section of R5 to exclude cattle from the easement area.

3.2.6 Reach R6 Enhancement

Work on Reach R6 involved two separate enhancement approaches. The upstream, 210-foot segment is incised, degraded, and widening. As such, Level I Enhancement was employed to flatten the bank angles and excavate floodplain benches throughout this section. The constructed channel dimensions had a width-to-depth ratio of 18.7 with 2.5:1 riffle side slopes, allowing the channel to narrow as buffer vegetation establishes. Combined with planting of native riparian buffer, this will protect against future channel erosion along the reach and enable long-term stability.

In the proposal stage, Baker had proposed Priority Level I restoration for this upper segment of Reach R6. The concept was to make this segment similar to a reference- quality segment just below it. However, the survey revealed that the incised segment is much steeper (valley slope is 0.037 ft/ft) than the reference segment and this likely exacerbated the instability. As such, it was not feasible to recreate the reference segment and an enhancement approach was utilized.

Below the upstream, degraded section, the mitigation approach transitioned to an Enhancement Level II that focused on the establishment of an easement, invasive species treatment, and supplemental buffer planting. No channel work was proposed or performed. Though the bank height ratios exceed 2.0 in some locations, the IRT felt that it was more important to maintain the existing vegetation, and that the smaller stream channel size meant that further erosion is likely to be limited.

One existing stream crossing on lower Reach R6 will be maintained and left out of the conservation easement. The piped crossing will remain in its current condition since it is stable and cattle do not have access to it.

3.2.7 Reach R7 Enhancement

Similar to Reach R6, work on Reach R7 included two different enhancement approaches. The upstream segment was degrading and had a very steep channel slope in the first 160 feet of 0.044 ft/ft. As such, a construction-heavy Enhancement Level II approach was utilized to stabilize the head cuts and channel gradient, as well as the unstable side slopes on the upper 360 feet of Reach R7. This work involved installing constructed riffles, log weirs, and rock step structures, some bank sloping and matting, and

supplemental riparian buffer planting. Wetlands are located just above the project reach and the aim is to prevent the headcut from migrating through and degrading this aquatic resource.

The lower 287-foot segment of Reach R7 was mostly stable with floodplain benches developing in several locations. The work conducted here was similar to lower Reach R6 and upper Reach R5, including easement establishment, invasive species treatment, and supplemental riparian buffer planting. There are no stream crossings on Reach R7.

3.2.8 Reach T1 Enhancement

Work on Reach T1 involved an Enhancement Level I approach. The channel was improved in the upper portion in its existing location by fencing an existing wetland area, then as construction moved downstream by grading back slopes, and by installing a step-pool sequence in the channel. Eventually it transitioned to a meandering channel with excavated benches that was constructed off-line until its confluence with Reach R2.

These techniques allowed for the enhancement of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, exclusion of cattle and associated pollutants, and decreased erosion and sediment loss from streambank erosion.

Mapped jurisdictional wetlands along Reach T1 were protected at the upper end. Below the crossing, they were enhanced through the construction process by incorporating them as floodplain benches, raising the stream bed, and thus increasing the hydro period. Additionally, wetland vegetation was reestablished and protected.

Riparian buffers in excess of 50 feet were restored along all of Reach T1, and invasive species treatment was conducted throughout. One stream crossing (and associated easement break) was constructed along upper Reach T1. The existing, eroding ford crossing was improved and fencing was installed to exclude cattle from the easement area.

3.2.9 Reach T2 Enhancement

Work on Reach T2 involved a Level II Enhancement approach to maintain channel stability and exclude cattle. The channel had two locations with abrupt grade changes, which would likely become headcuts if tree roots were not there to prevent that. The channel also lacked any pool habitat. Thus, grade control structures were installed to stabilize the headcuts and help form pools to provide increased bedform diversity. Additionally, a stable confluence was constructed where the channel ties back into Reach R2.

Riparian buffers in excess of 50 feet were restored along all of Reach T2, and invasive species treatment was conducted throughout. Cattle, which used this channel as a favorite wallow area, were permanently excluded with fencing. No stream crossings are located along Reach T2.

3.3 Project History, Contacts, and Attribute Data

Baker implemented the project under a full delivery contract with NCDMS to provide stream mitigation credits in the Cape Fear River Basin. The chronology of the project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant project background information is presented in Table 4. Tables 2, 3, and 4 are located in Appendix A of this report. As-built stationing is outlined in the Construction Summary, below, and in Table 1 in Appendix A.

3.3.1 Construction Summary

In accordance with the approved Mitigation Plan and regulatory permits, site preparation activities began on May 20, 2015 with the installation of sedimentation and erosion control measures, and the

establishment of staging areas, haul roads, and stockpile areas. The construction contractor for the project was River Works, Inc. (River Works). Actual in-stream structure location and placement varied slightly from the design plans in various sections (as described below) due to unexpected locations of exposed bedrock or adjacent springs/seeps, as well as to increase vertical stability at various locations along the project. Any substitutions and/or relocations were made based on existing field conditions and best professional judgment. The as-built plan sheets/record drawings depict actual surveyed areas within the project area and depict any changes from the final design plans to what was implemented on-site during construction. The as-built plan sheets/record drawings are located in Appendix C.

Channel construction started in late May 2015 on Reach R3. During construction of this reach, the discovery of extensive shallow bedrock from station 17+00 down to the existing crossing necessitated the installation of a rock riffle as substitute for a log jam, as well as the inability to cut the left floodplain bench for approximately 75 ft of channel from Station 18+00 to 18+75. Also, a boulder rock shelf was built along the left bank of the channel immediately downstream of the pipe crossing to protect against scour.

During the construction of Reach R2, some minor modifications to the floodplain benching were made in the upstream section to avoid removing a few existing mature white oak trees, and five eroding gullies that drained into R2 were stabilized with fill and covered with seed/matting. A boulder shelf was also added along the right channel bank at the outfall location of one of the more significant drainages at station 25+60 to help ensure stability during high flow events.

Work on upper Reach R7 substituted rock checks for a log jam at the top of a gully at Station 13+50. It was noted during construction that the drainage did not receive nearly as much water as it was initially assumed and that the wooden log jam would simply rot in place.

On Reach R5, rock riffles were substituted for three of the proposed log-jams, and another rock riffle was added beginning at Station 37+00. The rock riffles help improve bed stability and will provide a greater range of in-stream habitat. The channel alignment was also slightly modified near Station 36+25 to 36+75 to avoid having to remove several mature trees.

During construction on Reach R1, shallow bedrock was discovered in the lowermost portion of the reach in the channel and extending into the banks and floodplain. As a result, a rock sill was substituted for the log weir in the channel near the bottom at Station 44+05, and the left floodplain benching was stopped at station 44+00. Despite the bedrock, a vegetated geolift was installed along the upper left bank near the very bottom of the reach to help stabilize the remaining steep bank slope.

Construction crews also treated any invasive vegetation observed throughout the riparian buffer during construction. Pockets of invasive species were discovered, in particular multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), and Chinese privet (*Ligustrum sinense*), especially along Reach R2.

Approximately 6,300 feet of permanent cattle exclusion fencing (woven wire) was installed outside the conservation easement boundary along Reaches R1, R2, T1, T2, R4, and R5, with access gates and rock crossings as shown on the as-built plan sheets. In addition, Baker worked with the landowner to install a new groundwater well and four permanent watering stations for the cattle outside of the project boundary.

Upon completion of stream work within the Site, sedimentation and erosion control measures such as temporary stream crossings, rock check dams, and silt fence were removed, coir fiber matting was installed along both stream banks, and all disturbed areas were stabilized with temporary and permanent seed and mulch before de-mobilizing from the Site. Baker and River Works met on site September 23, 2015 and conducted a preliminary final walk through inspection, and generated a punch-list of final items to be completed. River Works completed this punch list and demobilized in early October 2015.

The planting of live-stakes and bare-root trees and shrubs was conducted in late January of 2016 for the entire project. The planting crew also searched for and removed any invasive species identified in Reaches R3 (upper), R5 (upper), R6, and R7. Some multiflora rose (*Rosa multiflora*) and Japanese honeysuckle (*Lonicera japonica*) were removed. Further invasive species inspections will be conducted again each year during the monitoring phase.

4.0 PERFORMANCE STANDARDS

Baker has obtained regulatory approval for numerous stream mitigation plans involving NCDOT and NCDMS full-delivery projects. The success criteria for the Site will follow the mitigation plan developed for this project, as well as the *Stream Mitigation Guidelines* (SMG) issued in April 2003 (USACE) and NCDMS's supplemental guidance document *Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation* dated November 7, 2011. All monitoring activities will be conducted for a period of 7 years, unless the Site demonstrates complete success by Year 5 and no concerns have been identified. An early closure provision may be requested by the provider for some or all of the monitoring components. Early closure may only be obtained through written approval from the USACE in consultation with the NCIRT.

Based on the design approaches, different monitoring methods are proposed for the project reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Levels I and/or II) and Enhancement Level I (stream bed/bank stabilization) approaches, geomorphic monitoring methods will follow those recommended by the 2003 SMG and the 2011 NCDMS supplemental guidance. For reaches involving Enhancement Level II approaches, monitoring efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments. The monitoring parameters shall be consistent with the requirements described in the Federal Rule for compensatory mitigation sites in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 paragraphs (a) and (b). Specific success criteria components and evaluation methods are described in Section 5.0 and report documentation will follow the NCDMS Baseline Monitoring Document template and guidance (v 2.0, dated 10/14/10).

5.0 MONITORING PLAN AND SUCCESS CRITERIA

5.1 Stream Monitoring

Geomorphic monitoring of the proposed restoration reaches will be conducted once a year for a minimum of seven years following the completion of construction to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross-sections), pattern (planimetric survey), profile (longitudinal profile survey), and visual observation with photographic documentation. The success criteria for the restored reaches will follow the methods described below for each parameter, though the Enhancement Level II reaches/sections will follow the methods described in sections 5.1.6 and 5.2. All monitoring features are shown in Figure 4 (Appendix A) as well as in the as-built plan sheets (Appendix D).

5.1.1 Bankfull Events and Flooding Functions

The occurrence of bankfull events within the monitoring period will be documented by the use of pressure transducers, a crest gauge, and photographs. Two pressure transducer gauges were installed in the restored channels of Reach R2 (upstream) and Reach R5 to record water depth and flow duration, as well as bankfull events in their respective reaches. A crest gauge was also installed on the floodplain of Reach R2 (downstream) within five feet (horizontal) of the restored channel bank. It will be used to document the highest watermark between site visits, and will be checked at each site visit to determine if a bankfull event has occurred. Photographs will also be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull flow events must be documented within the five- to seven-year monitoring period. The two bankfull events must occur in separate years; otherwise, the monitoring will continue until two bankfull events have been documented in separate years.

5.1.2 Cross-sections

Permanent cross-sections were installed at a rate of one cross-section per twenty bankfull widths of restored stream, not to exceed 500 LF. At Thomas Creek, ten cross-sections were established at riffles, and six at pools. Each cross-section was marked on both stream banks with permanent monuments using rebar cemented in place to establish the exact transect used. A common benchmark will be used for cross-sections and consistently used to facilitate easy comparison of year-to-year data. The cross-section surveys will occur in Years 1, 2, 3, 5, and 7, and must include measurements of Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of stream banks, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

There should be little change in as-built cross-sections. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the stream banks, or decrease in width/depth ratio). Using the Rosgen Stream Classification System, and all monitored cross-sections should fall within the quantitative parameters (i.e. BHR no more than 1.2 and ER no less than 2.2 for 'C' stream types) defined for channels of the design stream type. Given the smaller channel sizes and meander geometry of the proposed streams, bank pins will not be installed unless monitoring results indicate active lateral erosion.

Reference photo transects will be taken at each permanent cross-section. Lateral photos should not indicate excessive erosion or continuing degradation of the stream banks. Photographs will be taken

of both stream banks at each cross-section. The survey tape will be centered in the photographs of the streambanks. The water line will be located in the lower edge of the frame, and as much of the stream bank as possible will be included in each photo. Photographers should make an effort to consistently maintain the same area in each photo over time.

5.1.3 Pattern

The planimetric measurements such as sinuosity, radius of curvature, and meander width ratio were taken from the as-built survey for the baseline (Year 0) only. Subsequent visual monitoring will be conducted twice a year, at least five months apart, to document any changes or excessive lateral movement along the restored channel.

5.1.4 Longitudinal Profile

A longitudinal profile was surveyed for the entire length of all the restored channels after construction to document the as-built baseline (Year 0) conditions only. This included Reach R1, Reach R2, Reach R3 (downstream), Reach R4 (downstream), Reach R5 (downstream), Reach R6 (upstream), and Reach T1. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile shows that the bedform features installed are consistent with intended design. The longitudinal profile will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary.

5.1.5 Bed Material Analysis

After construction, there should be minimal change in the pebble count data over time given the current watershed conditions and sediment supply regime. Changes in particle sizes or size distribution within the two pebble count locations in constructed riffles should be evaluated as to whether the changes are indicators of instability. Two pebble count samples were collected on Reach R2 (downstream) and Reach R5 where constructed riffles were installed as part of the project. Additional samples will be collected in the same riffle locations each subsequent monitoring year and compared to the data from previous years. Any significant changes (i.e.; aggradation, degradation) will be noted after stream bank vegetation becomes established and a minimum of two bankfull flows or greater have been documented.

5.1.6 Visual Assessment

Visual monitoring assessments of all stream sections will be conducted by qualified personnel twice per monitoring year with at least five months in between each site visit. Photographs will be used to visually document system performance and any areas of concern related to stream bank stability, condition of in-stream structures, channel migration, headcuts, live stake mortality, impacts from invasive plant species or animal species, and condition of pools and riffles. The photo locations are shown on Figure 4 and will be shown on a plan view map per NCDMS's monitoring report guidance (v1.5, June 2012).

The photographs will be taken from a height of approximately five to six feet from the same locations and view directions on the Site for each monitoring period. A series of photos over time will be also be used to subjectively evaluate channel aggradation (bar formations) or degradation, stream bank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures.

5.2 Vegetation Monitoring

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, vegetation-monitoring quadrants were installed and will be monitored across the Site in accordance with the CVS-NCDMS Protocol for Recording Vegetation, Version 4.2 (2008). The vegetation monitoring plots are a minimum of 2 percent of the planted portion of the Site with a minimum of nine plots established randomly within the planted riparian buffer areas per Monitoring Levels 1 and 2. The size of individual quadrants are 100 square meters for woody tree species. No monitoring quadrants were established within the undisturbed areas of Reaches R4, R5, R6 and R7.

Vegetation monitoring will occur in the fall, prior to the loss of leaves. Individual quadrant data will be provided and will include species diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked such that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

All monitoring devices were installed by March 2016. All buffer vegetation was planted in January 2016. The approved contract with NCDMS requires that all vegetation must be planted at least six months (180 days) before (Year 1) monitoring activities are conducted at the end of the first full growing season.

The vegetation plots will be monitored annually for seven years, or until the final success criteria are achieved. The restored Site will be evaluated between September and November. The interim measure of vegetative success for the Site will require the survival of at least 320, 3-year old, planted trees per acre at the end of Year 3 of the monitoring period. At Year 5, density must be no less than 260, 5-year old, planted trees per acre. The final vegetative success criteria will be the survival of 210, 7-year old, planted trees per acre at the end of the seven-year monitoring period, which must average 10 feet in height. However, if the performance standard is met by Year 5 and stem densities are greater than 260, 5-year old stems/acre, vegetation monitoring may be terminated with approval by the USACE and Interagency Review Team (IRT).

While measuring species density and height is the current accepted methodology for evaluating vegetation success on mitigation projects, species density and height alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices, native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

Baker will provide any required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species, beaver management/dam removal, or removing undesirable/invasive species vegetation, and continue to monitor vegetation performance until the corrective actions demonstrate that the Site is trending towards or meeting the standard requirement.

Additionally, herbaceous vegetation, primarily native grasses and forbs, was seeded/planted throughout the Site. During and immediately following construction activities, all ground cover at the project Site was in compliance with the NC Erosion and Sedimentation Control requirements.

5.3 Wetland Monitoring

No wetland credits were proposed for the Site, therefore, no such monitoring is required.

5.4 Stormwater Management Monitoring

No stormwater BMPs were proposed for the Site. Therefore, no such monitoring is required.

6.0 AS-BUILT DATA DOCUMENTATION

Stream and vegetation components will be monitored for seven years post-construction to evaluate project success, unless the Site demonstrates complete success by Year 5 and no areas of concern have been identified. The specific locations of vegetation plots, flow/crest gauges, and cross-sections are shown on the as-built plan sheets.

6.1 Stream Data

One manual crest gauge was installed at the bankfull elevation along the restored channel of Reach R2 (downstream) and will be used to document the occurrence of bankfull events on the downstream portion of the Site. Additionally, two in-channel pressure transducers were installed in Reach 2 (upstream) and Reach 5 (downstream). The in-channel pressure transducers will record water depth and flow duration within the channels as well as document bankfull events in the respective reaches. Photographs will also be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

For monitoring stream success criteria, sixteen permanent cross-sections were installed along all restored reaches on the Site. The permanent cross-sections will be used to monitor channel dimension and bank stability over time.

In addition, a longitudinal survey was completed for the restored stream channels (Reach R1, Reach R2, Reach R3 (downstream), Reach R4 (downstream), Reach R5 (downstream), Reach R6 (upstream), and Reach T1) to provide a baseline for evaluating changes in bed conditions over time. The permanent as-built cross-sections (with photos), the as-built longitudinal data, the quantitative pre-construction, reference reach, and design data used to determine restoration approach, as well as other as-built data including Reach 2 and Reach 5 pebble count samples are all provided in Appendix B. As-built data will be used for comparison to post-construction monitoring data. The locations of the permanent cross-sections and the crest gauges are shown in Figure 4 in Appendix A, and on the as-built plan sheets in Appendix D. Photographs of the selected portions of the restored reaches are provided in Appendix E.

6.2 Vegetation Data

Bare-root trees and shrubs were planted within restoration and enhancement areas of the conservation easement. A minimum 50-foot buffer was established and/or protected along both banks of all stream reaches. Planting of bare-root trees and shrubs and live stakes was completed in January 2016.

The Mitigation Plan for the Site specifies that the number of quadrants required shall be based on the CVS-NCDMS monitoring guidance (2007). The total number of quadrants was calculated using the CVS-NCDMS Entry Tool Database version 2.2.7 (CVS-NCDMS, 2007). The sizes of individual quadrants are 100 square meters. A total of sixteen vegetation plots were installed throughout the Site. The initial planted density within each of the vegetation monitoring plots is provided in Table 8. The average density of planted bare root stems, based on the data from the sixteen vegetation monitoring plots, is 784 stems per acre. The locations of the vegetation plots are shown on the as-built plan sheets in Appendix D.

6.3 Areas of Concern

No areas of concern were identified post-construction for the site.

7.0 MAINTENANCE AND CONTINGENCY PLANS

Maintenance requirements vary from site to site and are generally driven by the following conditions:

- Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest.
- Projects with sandy, non-cohesive soils are more prone to bank erosion than cohesive soils or soils with high gravel and cobble content.
- Alluvial valley channels with access to their floodplain are less vulnerable to erosion than channels that have been disconnected from their floodplain.
- Wet weather during construction can make accurate channel and floodplain excavations difficult.
- Extreme and/or frequent flooding can cause floodplain and channel erosion.
- Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed.
- The presence and aggressiveness of invasive vegetation species can affect the extent to which a native species vegetation buffer can be established.
- The presence of beaver can affect vegetation survivability and stream function.

The Site will be monitored on a regular basis and as well as a physical inspection of the Site at least twice a year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Maintenance issues and recommended remediation measures will be detailed and documented in the post-construction monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. Routine maintenance, if required, will be most likely be needed in the first two years following site construction and may include the following components as described below.

7.1 Streams

Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent stream bank failures and head-cutting until vegetation becomes established.

7.2 Wetland

No wetland mitigation was proposed for the Site; therefore, no such maintenance is required.

7.3 Vegetation

Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will be treated by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.

7.4 Site Boundary

Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

7.5 Farm Road Crossing

The farm road crossings within the Site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.

7.6 Beaver Management

Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dam breeching/dewatering and/or removal. Beaver management will be performed in accordance with US Department of Agriculture (USDA) rules and regulations using accepted trapping and removal techniques only within the project boundary on an as-needed basis.

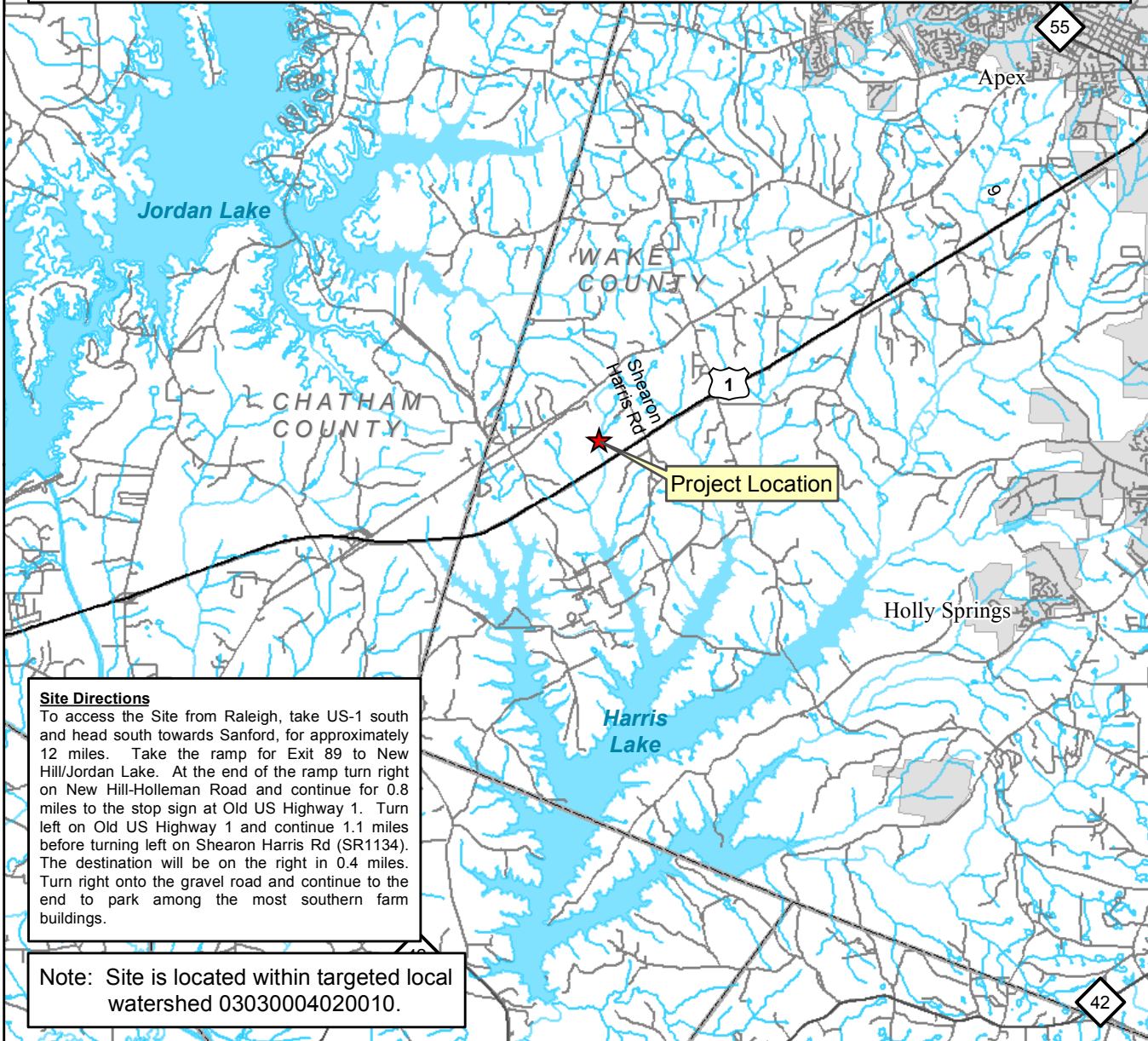
8.0 REFERENCES

- Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCDMS). 2007. CVS-NCDMS Data Entry Tool v. 2.2.7. University of North Carolina, Raleigh, NC.
- Lee, M., Peet R., Roberts, S., Wentworth, T. CVS-NCDMS Protocol for Recording Vegetation, Version 4.1, 2007.
- North Carolina Division of Mitigation Services. 2011. Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation. November 7, 2011.
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- Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation, NCDENR. Raleigh, NC.
- United States Army Corps of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Environmental Laboratory. US Army Engineer Waterways Experiment Station. Vicksburg, MS.
- _____. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

APPENDIX A

Figures 1 - 4, Tables 1 - 4

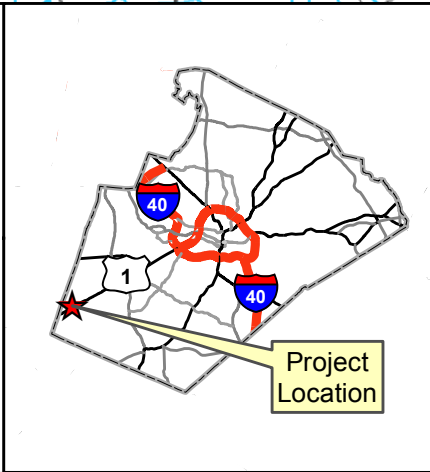
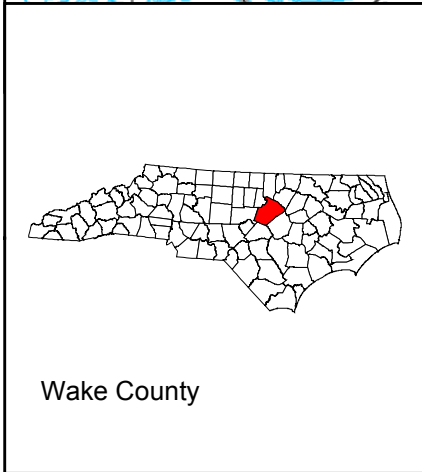
The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with DMS.



Site Directions

To access the Site from Raleigh, take US-1 south and head south towards Sanford, for approximately 12 miles. Take the ramp for Exit 89 to New Hill/Jordan Lake. At the end of the ramp turn right on New Hill-Holleman Road and continue for 0.8 miles to the stop sign at Old US Highway 1. Turn left on Old US Highway 1 and continue 1.1 miles before turning left on Shearon Harris Rd (SR1134). The destination will be on the right in 0.4 miles. Turn right onto the gravel road and continue to the end to park among the most southern farm buildings.

Note: Site is located within targeted local watershed 03030004020010.



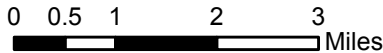
**Figure 1 - Project Vicinity Map
Thomas Creek Site
DMS Project ID No. 96074**

**NCDEQ -
Division of
Mitigation Services**



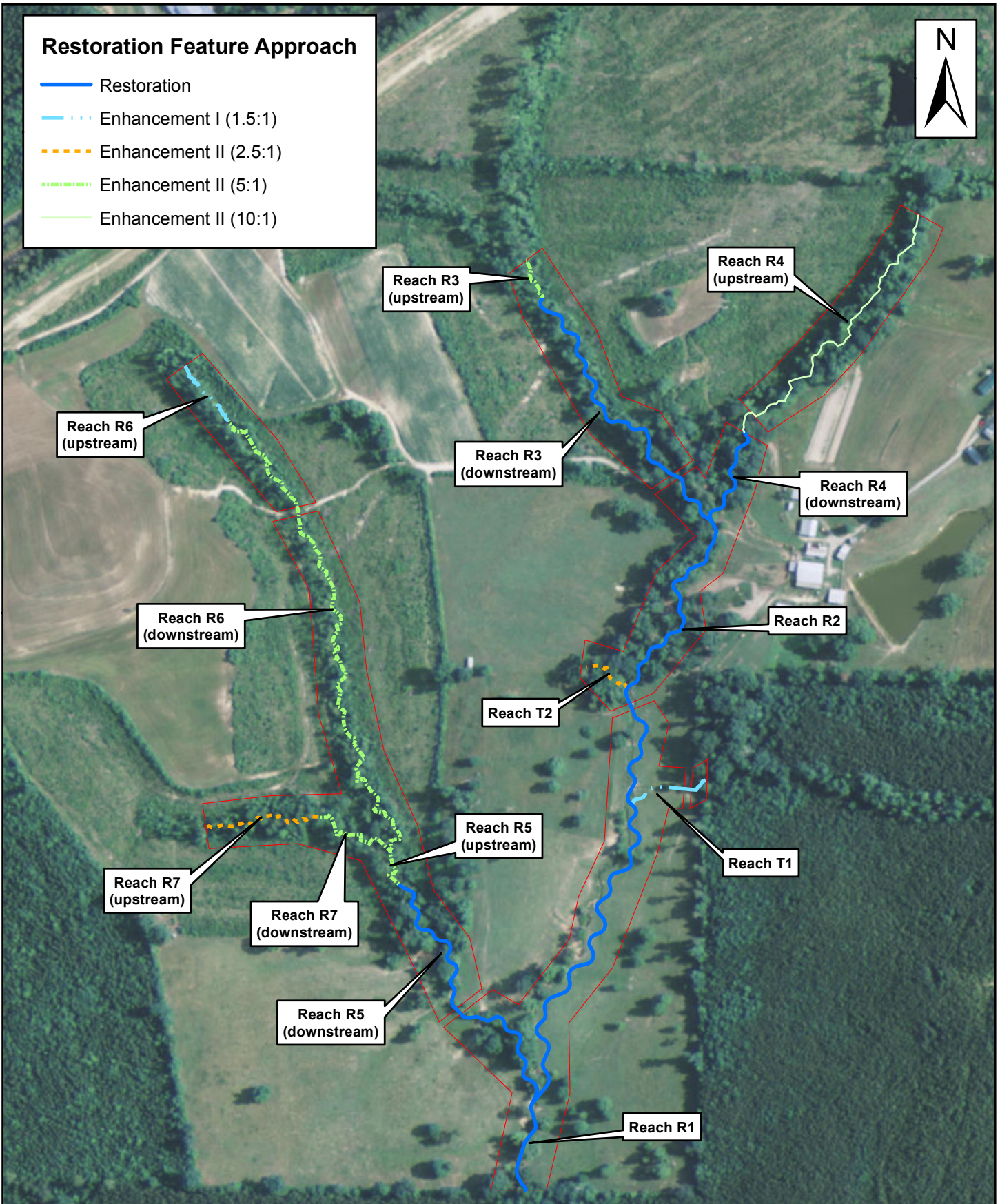
Michael Baker

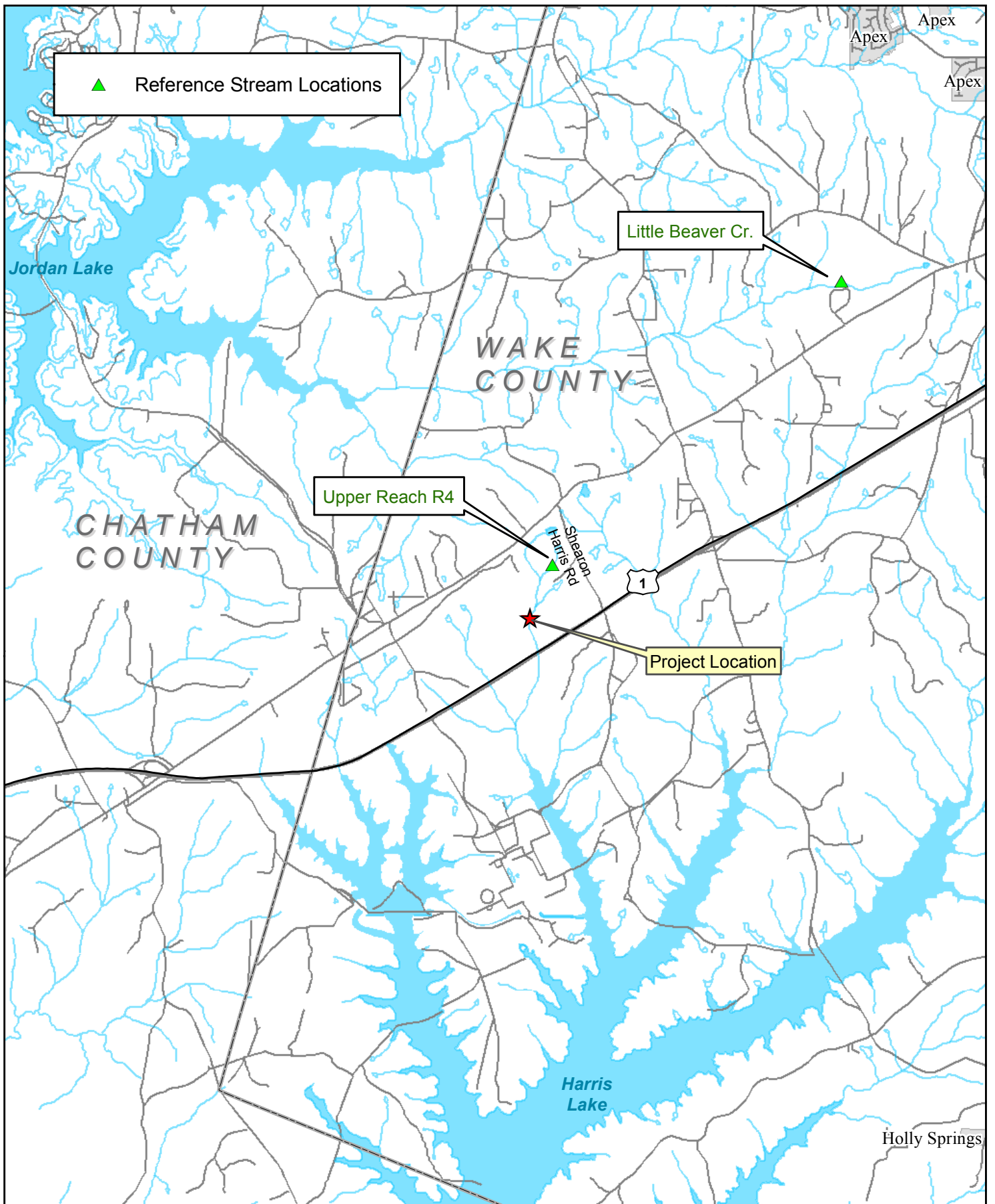
INTERNATIONAL



Restoration Feature Approach

- Restoration
- - - Enhancement I (1.5:1)
- - - Enhancement II (2.5:1)
- - - Enhancement II (5:1)
- - - Enhancement II (10:1)





<p>Michael Baker INTERNATIONAL</p>	<p>NCDEQ - Division of Mitigation Services</p>	<p>0 0.5 1 Miles</p>	<p>N ↑</p>	<p>Figure 3 Reference Stream Locations Map Thomas Creek Site</p>
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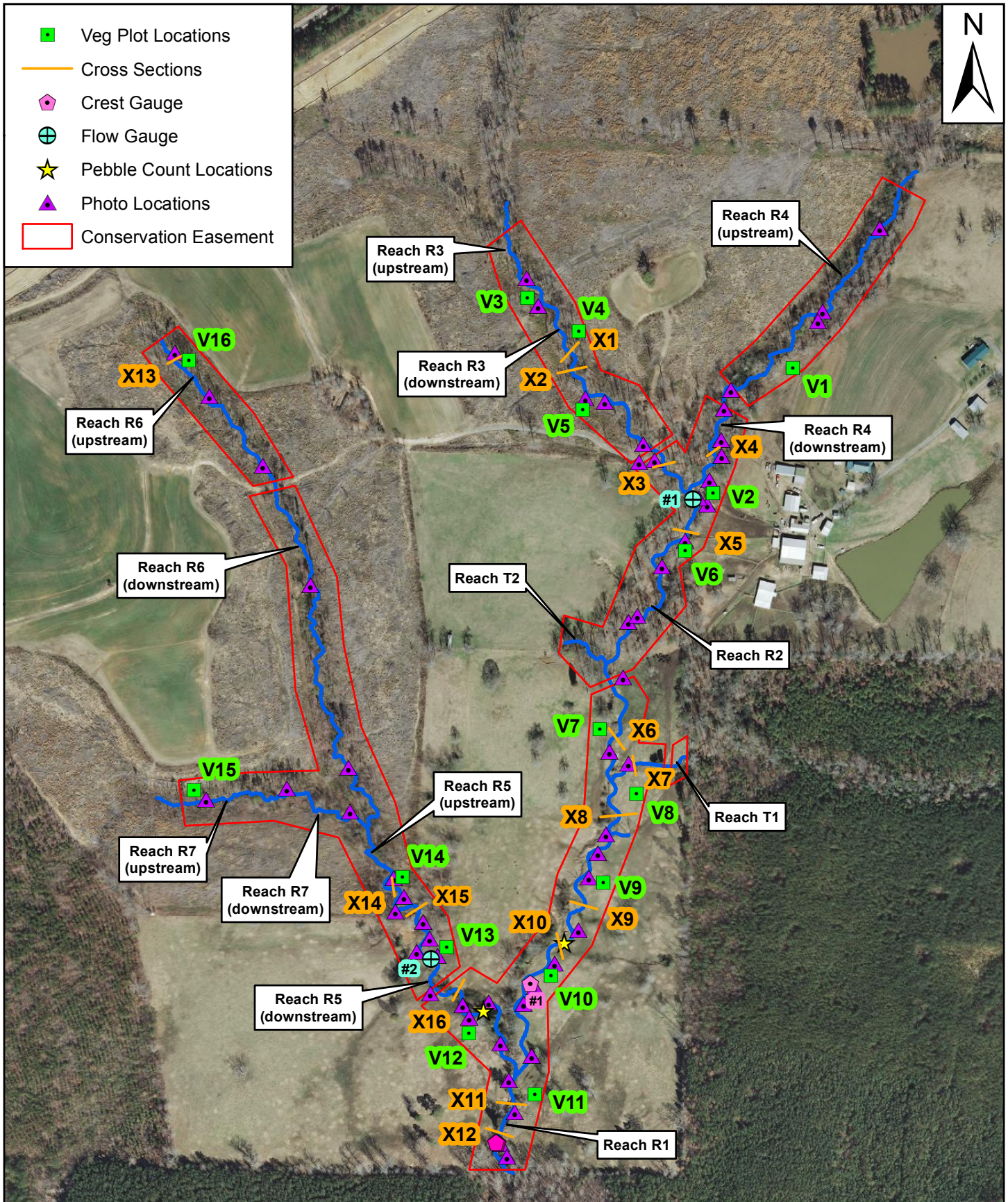


Figure 4
Monitoring Features
Overview Map
Thomas Creek Site

Table 1. Project Components and Mitigation Credits								
Thomas Creek Restoration Project: DMS Project No ID. 96074								
Mitigation Credits								
	Stream	Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R, E1, EII							
Totals	5,728 SMU							
Project Components								
Project Component or Reach ID	Stationing/ Location		Existing Footage/ Acreage (LF)	Approach	Restoration/ Restoration Equivalent (SMU)	Restoration Footage or Acreage (LF)	Mitigation Ratio	
Reach 1	42+01 to 44+99		397	Restoration	298	298	1:1	
Reach 2	20+55 to 27+58 / CE Break / 27+78 to 42+01		1,995	Restoration	2,126	2,126	1:1	
Reach 3 (downstream)	11+17 to 18+70 / CE Break / 18+94 to 20+55		937	Restoration	914	914	1:1	
Reach 3 (upstream)	10+00 to 11+17		130	Enhancement II	23	117	5:1	
Reach 4 (downstream)	10+41 to 13+83		327	Restoration	342	342	1:1	
Reach 4 (upstream)	0+99 to 9+95		870	Enhancement II	90	896	10:1	
Reach 5 (downstream)	29+30 to 34+97 / CE Break / 35+17 to 39+91		883	Restoration	1,041	1,041	1:1	
Reach 5 (upstream)	28+02 to 29+30		137	Enhancement II	26	128	5:1	
Reach 6 (downstream)	12+10 to 15+55 / CE Break / 15+81 to 28+02		1,592	Enhancement II	313	1,566	5:1	
Reach 6 (upstream)	10+00 to 12+10		210	Enhancement I	140	210	1.5:1	
Reach 7 (downstream)	13+60 to 16+47		287	Enhancement II	57	287	5:1	
Reach 7 (upstream)	10+00 to 13+60		360	Enhancement II	144	360	2.5:1	
Reach T1	10+00 to 10+55 / CE Break / 10+75 to 12+47		242	Enhancement I	151	227	1.5:1	
Reach T2	10+00 to 11+57		171	Enhancement II	63	157	2.5:1	
Component Summation								
Restoration Level	Stream (LF)		Riparian Wetland (AC)		Non-riparian Wetland (AC)		Buffer (SF)	Upland (AC)
Restoration	4,721							
Enhancement I	437							
Enhancement II	3,511							
BMP Elements								
Element	Location	Purpose/Function			Notes			
BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area								

Table 2. Project Activity and Reporting History			
Thomas Creek Restoration Project: DMS Project No ID. 96074			
Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	N/A	N/A	Oct-14
Mitigation Plan Amended	N/A	N/A	Mar-15
Mitigation Plan Approved	Feb-15	N/A	Mar-15
Final Design – (at least 90% complete)	N/A	N/A	Mar-15
Construction Begins	Apr-15	N/A	Apr-15
Temporary S&E mix applied to entire project area	Oct-15	N/A	Oct-15
Permanent seed mix applied to entire project area	Oct-15	N/A	Oct-15
Planting of live stakes	Mar-15	N/A	Jan-16
Planting of bare root trees	Mar-15	N/A	Jan-16
End of Construction	Oct-15	N/A	Oct-15
Survey of As-built conditions (Year 0 Monitoring-baseline)	Jan-16	Nov-15	Nov-15
Baseline Monitoring Report	Jun-16	Mar-16	Oct-16
Year 1 Monitoring	Dec-16	N/A	N/A
Year 2 Monitoring	Jan-17	N/A	N/A
Year 3 Monitoring	Jan-18	N/A	N/A
Year 4 Monitoring	Jan-19	N/A	N/A
Year 5 Monitoring	Jan-20	N/A	N/A
Year 6 Monitoring	Jan-21	N/A	N/A
Year 7 Monitoring	Dec-22	N/A	N/A

Table 3. Project Contacts	
Thomas Creek Restoration Project: DMS Project ID No. 96074	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u> Scott King, Tel. 919-481-5731
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 <u>Contact:</u> Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 <u>Contact:</u> Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 <u>Contact:</u> Phillip Todd, Tel. 919-582-3575
Seed Mix Sources	Green Resources, Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u>
Stream Monitoring Point of Contact	Scott King, Tel. 919-481-5745
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5746

Table 4. Project Attributes					
Thomas Creek Restoration Project: DMS Project No. ID 96074					
Project Information					
Project Name	Thomas Creek Restoration Project				
County	Wake				
Project Area (acres)	22.7				
Project Coordinates (latitude and longitude)	35.6636 N, -79.9547 W				
Project Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Cape Fear				
USGS Hydrologic Unit 8-digit and 14-digit	03030004 / 03030004020010				
NCDWR Sub-basin	03-06-07				
Project Drainage Area (acres)	246 (Reach R1 main stem at downstream extent)				
Project Drainage Area Percent Impervious	<1%				
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (66%) Agriculture (19%) Impervious Cover (1%)				
Reach Summary Information					
Parameters	Reach R1	Reach R2	Reach R3	Reach R4	Reach R5
Length of Reach (linear feet)	397	1,995	1,067	342	1,020
Valley Classification (Rosgen)	VII	VII	VII	VII	VII
Drainage Area (acres)	246	176	62	36	62
NCDWR Stream Identification Score	37.5	38	25 / 37	31	31 / 34
NCDWR Water Quality Classification	C				
Morphological Description (Rosgen stream type)	Bc	F (upstream)/ Gc (downstream)	Gc (upstream)/ Bc (downstream)	Bc	Bc
Evolutionary Trend	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F
Underlying Mapped Soils	WoA	WoA	WoA	WoA	WoA
Drainage Class	Poorly drained	Poorly drained	Poorly drained	Poorly drained	Poorly drained
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0165	0.0083	0.014	0.0102	0.0172
FEMA Classification	N/A	N/A	N/A	N/A	N/A
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	25%	<5%	<5%	<5%
Parameters	Reach R6	Reach R7	Reach T1	Reach T2	
Length of Reach (linear feet)	1,828	646	242	171	
Valley Classification (Rosgen)	VII	VII	VII	VII	
Drainage Area (acres)	32	14	49	5	
NCDWR Stream Identification Score	25 / 30	23 / 35	23.75	20.75	
NCDWR Water Quality Classification	C				
Morphological Description (Rosgen stream type)	G5c (upstream)/ B5c (downstream)	G5 (upstream)/ B5c (downstream)	B5c	B5c	
Evolutionary Trend	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	
Underlying Mapped Soils	WoA	WoA	WoA	WoA	
Drainage Class	Poorly drained	Poorly drained	Poorly drained	Poorly drained	
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	
Average Channel Slope (ft/ft)	0.015/0.025	0.025	0.02	0.041	
FEMA Classification	N/A	N/A	N/A	N/A	
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%	<5%	
Regulatory Considerations					
Regulation	Applicable	Resolved	Supporting Documentation		
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)		
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)		
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)		
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)		
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)		
FEMA Floodplain Compliance	No	Yes	Categorical Exclusion (Appendix B)		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion (Appendix B)		

APPENDIX B

Morphological Summary Data (Tables 5 and 6),
Profile and Cross-Section Graphs, and Pebble
Count Sheets

Table 5. Baseline Stream Summary																												
Thomas Creek Restoration Project: DMS Project ID No. 96074																												
Reach 1 - Length 298 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built					
											Little Beaver Creek (Wake County)																	
Dimension and Substrate - Riffle		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)		----	11.6	11.9	----	----	----	9.0	----	----	----	----	----	----	----	----	----	12.5	----	----	----	----	----	----	13.9	----	----	
Floodprone Width (ft)		----	----	----	----	----	----	9.0	----	----	----	----	----	----	----	----	----	>25	----	----	----	----	----	----	30.6	----	----	
BF Mean Depth (ft)		----	1.2	1.5	----	----	----	1.2	----	----	----	----	----	----	----	----	----	0.9	----	----	----	----	----	----	0.8	----	----	
BF Max Depth (ft)		----	----	----	----	----	----	1.9	----	----	----	----	----	----	----	----	----	1.1	----	----	----	----	----	----	1.1	----	----	
BF Cross-sectional Area (ft ²)		----	----	11.2	----	----	----	11.2	----	----	----	----	----	----	----	----	----	11.2	----	----	----	----	----	----	11.1	----	----	
Width/Depth Ratio		----	----	----	----	----	----	7.2	----	----	12.0	----	----	18.0	----	----	----	14.0	----	----	----	----	----	----	17.4	----	----	
Entrenchment Ratio		----	----	----	----	----	----	1.8	----	----	1.4	----	----	2.2	----	----	----	>2.2	----	----	----	----	----	----	2.2	----	----	
Bank Height Ratio		----	----	----	----	----	----	2.5	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	----	1.0	----	----	
d50 (mm)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pattern																												
Channel Beltwidth (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	30.0	----	----	----	----	----	----	34.4	----	----	
Radius of Curvature (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	25.0	----	----	35.0	----	----	----	----	33.1	----	----	
Rc:Bankfull width (ft/ft)		----	----	----	----	----	----	----	----	----	2.0	----	----	3.0	----	----	2.0	----	----	2.8	----	----	----	----	2.4	----	----	
Meander Wavelength (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	105.0	----	----	----	----	103.4	----	----	
Meander Width Ratio		----	----	----	----	----	----	----	----	----	3.5	----	----	8.0	----	----	----	2.4	----	----	----	----	----	----	2.5	----	----	
Profile																												
Riffle Length (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	24.0	----	----	
Riffle Slope (ft/ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.028	----	----	----	----	0.025	----	----	
Pool Length (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	24	----	----	60	----	----	----	----	64.0	----	----	
Pool Max Depth (ft)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.4	----	----	----	----	2.5	----	----	
Pool Volume (ft ³)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
d16 / d35 / d50 / d84 / d95		----	----	----	----	----	----	0.15 / 0.27 / 0.34 / 0.75 / 1.39	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft ²		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Max part size (mm) mobilized at bankfull (Rosgen Curve)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Stream Power (transport capacity) W/m ²		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Additional Reach Parameters																												
Drainage Area (SM)		----	----	----	----	----	----	0.38	----	----	----	----	----	----	----	----	----	----	0.38	----	----	----	----	----	----	0.38	----	
Impervious cover estimate (%)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification		----	----	----	----	----	----	E	----	----	----	----	C5	----	----	----	----	----	C5	----	----	----	----	----	----	C5	----	
BF Velocity (fps)		----	3.4	4.0	----	----	----	3.9	----	----	3.5	----	----	5	----	----	----	----	4	----	----	----	----	----	----	----	----	
BF Discharge (cfs)		----	27.6	44.6	----	----	----	44.6	----	----	----	----	----	----	----	----	----	----	44.6	----	----	----	----	----	----	----	----	
Valley Length		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	271.1	----	----	
Channel length (ft)		----	----	----	----	----	----	397	----	----	----	----	----	----	----	----	----	----	266	----	----	----	----	----	324.3	----		
Sinuosity		----	----	----	----	----	----	1.18	----	----	1.1	----	----	1.3	----	----	----	----	1.22	----	----	----	----	----	1.2	----		
Water Surface Slope (Channel) (ft/ft)		----	----	----	----	----	----	0.0028	----	----	----	----	----	----	----	----	----	----	0.022	----	----	----	----	----	0.0168	----		
BF slope (ft/ft)		----	----	----	----	----	----	0.0050	----	----	0.002	----	----	0.015	----	----	----	----	0.0165	----	----	----	----	----	0.0201	----		
Bankfull Floodplain Area (acres)		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BEHI VL% / L% / M% / H% / VH% / E%		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel Stability or Habitat Metric		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Biological or Other		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

1 - Pre-Existing Condition measurement taken on existing sandbed riffle

Table 5 continued. Baseline Stream Summary																												
Thomas Creek Restoration Project: DMS Project ID No. 96074																												
Reach 2 - Length 2,126 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built					
											Little Beaver Creek (Wake County)																	
Dimension and Substrate - Riffle		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)		11.6	11.9		6.5			9.4									9.2			10.4			10.2	10.3		10.4		
Floodprone Width (ft)					9.0			13.2										>18					38.2	58.5		74.5		
BF Mean Depth (ft)		1.2	1.5		0.6			1.2									0.7			0.7			0.7	0.8		1.0		
BF Max Depth (ft)					1.6			2.6									0.8			1.0			1.0	1.2		1.5		
BF Cross-sectional Area (ft²)		6.0	7.7		7.7			15.7									6.0			7.7			7.4	8.6		10.2		
Width/Depth Ratio					3.4			5.4			10.0			15.0			14.0			14.0			10.1	12.5		14.8		
Entrenchment Ratio					1.4			1.4						>2.2				>2.2					3.7	5.7		6.2		
Bank Height Ratio					2.2			3.3			1.0			1.1				1.0					1.0	1.0		1.0		
d50 (mm)																												
Pattern																												
Channel Beltwidth (ft)																	32.0			45.0				56.6				
Radius of Curvature (ft)																	17.0			30.0				22.0				
Re:Bankfull width (ft/ft)											2.0			3.0			2.0			3.0				2.1				
Meander Wavelength (ft)																	75.0			107.0				83.2				
Meander Width Ratio											7.0			14.0			3.3			4.7				5.5				
Profile																												
Riffle Length (ft)																								17.7				
Riffle Slope (ft/ft)																	0.0094			0.02				0.012				
Pool Length (ft)																												
Pool to Pool Spacing (ft)																	25			75				50.8				
Pool Max Depth (ft)																	1.7			1.9				1.7				
Pool Volume (ft³)																												
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%																												
SC% / Sa% / G% / B% / Be%																												
d16 / d35 / d50 / d84 / d95								0.11 / 0.22 / 0.32 / 0.85 / 1.89																20.2 / 47.6 / 62.5 / 133.1 / 173.1				
Reach Shear Stress (competency) lb/ft²																												
Max part size (mm) mobilized at bankfull (Rosgen Curve)																												
Stream Power (transport capacity) W/m²																												
Additional Reach Parameters																												
Drainage Area (SM)					0.153			0.275												0.275						0.275		
Impervious cover estimate (%)																												
Rosgen Classification					G5c			F5					C5						C5						C5			
BF Velocity (fps)		3.2	3.9		3.8			3.9			3.5			5			3.8			3.9								
BF Discharge (cfs)		17.8	29.7		22.9			35.0									23.0			29.7								
Valley Length																										2549.3		
Channel length (ft)								1995												1089						3413.7		
Sinuosity						1.17					1.2			1.5						1.20						1.3		
Water Surface Slope (Channel) (ft/ft)						0.0082											0.0047			0.0083						0.0092		
BF slope (ft/ft)						0.0098					0.002			0.01						0.01						0.0123		
Bankfull Floodplain Area (acres)																												
BEHI VL% / L% / M% / H% / VH% / E%																												
Channel Stability or Habitat Metric																												
Biological or Other																												

1 - Pre-Existing Condition measurement taken on existing sandbed riffle, As-Built measurement taken on constructed rock riffle

Table 5 continued. Baseline Stream Summary																													
Thomas Creek Restoration Project: DMS Project ID No. 96074																													
Reach 3 - Length 1,031 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built						
											Thomas Creek Site Upper Reach 4 (On-site)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
Dimension and Substrate - Riffle																													
	BF Width (ft)	----	11.6	11.9	----	4.5	----	----	5.3	----	----	----	----	----	----	----	----	7.0	----	----	----	----	7.5	8.4	----	9.3	----	----	
	Floodprone Width (ft)	----	----	----	----	6.7	----	----	9.5	----	----	----	----	----	----	----	----	>16	----	----	----	----	37.3	46.3	----	55.3	----	----	
	BF Mean Depth (ft)	----	1.2	1.5	----	0.7	----	----	0.8	----	----	----	----	----	----	----	----	0.7	----	----	----	----	0.6	0.7	----	0.8	----	----	
	BF Max Depth (ft)	----	----	----	----	1.0	----	----	1.5	----	----	----	----	----	----	----	----	0.7	----	----	----	----	0.9	0.9	----	1.29	----	----	
	BF Cross-sectional Area (ft²)	----	26.8	36.2	----	3.0	----	----	4.3	----	----	----	----	----	----	----	----	4.1	----	----	----	----	4.5	5.9	----	7.3	----	----	
	Width/Depth Ratio	----	----	----	----	6.5	----	----	6.7	----	10	----	----	14.0	----	----	11.0	12.0	----	13.0	----	----	11.9	12.1	----	12.3	----	----	
	Entrenchment Ratio	----	----	----	----	1.5	----	----	1.8	----	----	----	----	>2.2	----	----	----	>2.2	----	----	----	----	5.0	5.5	----	5.9	----	----	
	Bank Height Ratio	----	----	----	----	2.3	----	----	3.2	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	1.0	1.0	----	1.0	----	----	
	d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pattern																													
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	18	----	----	28	----	----	----	32.2	----	----	----	----	
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	15	----	----	21	----	----	----	19.1	----	----	----	----	
	Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	2	----	----	3	----	----	2.0	----	----	2.7	----	----	----	2.3	----	----	----	----	
	Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	70	----	----	80	----	----	----	77.5	----	----	----	----	
	Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.6	----	----	4.0	----	----	----	3.8	----	----	----	----	
Profile																													
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12.5	----	----	----	----	
	Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	1.1	----	----	2.0	----	----	----	0.031	----	----	----	----	----	0.013	----	----	----	----	
	Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	28.0	----	----	48.0	----	----	----	47.2	----	----	----	----	
	Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.5	----	----	----	----	----	1.3	----	----	----	----	
	Pool Volume (ft³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Substrate and Transport Parameters																													
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Reach Shear Stress (competency) lb/ft²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Additional Reach Parameters																													
	Drainage Area (SM)	----	----	----	----	----	----	0.083	----	----	----	----	----	----	----	----	----	----	----	0.083	----	----	----	0.083	----	----	----	----	
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Rosgen Classification	----	----	----	----	----	----	B5c	----	----	----	----	----	E/C5	----	----	----	----	----	E/C5	----	----	----	----	----	C5	----	----	
	BF Velocity (fps)	----	3.0	3.6	----	3.8	----	----	2.3	----	3.5	----	----	5	----	----	----	----	----	3.8	----	----	----	----	----	----	----	----	
	BF Discharge (cfs)	----	9.4	16.5	----	12.2	----	----	16.5	----	----	----	----	----	----	----	----	----	----	16.5	----	----	----	----	----	----	----	----	
	Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2549.3	----	----	----	
	Channel length (ft)	----	----	----	----	----	----	1,067	----	----	----	----	----	----	----	----	----	----	----	1,231	----	----	----	----	3413.7	----	----	----	
	Sinuosity	----	----	----	----	----	----	1.22	----	----	1.20	----	----	1.50	----	----	----	----	----	1.20	----	----	----	----	1.3	----	----	----	
	Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0150	----	----	----	----	----	----	----	----	----	----	----	0.0150	----	----	----	----	0.0092	----	----	----	
	BF slope (ft/ft)	----	----	----	----	----	----	0.0182	----	----	0.005	----	----	0.015	----	----	----	----	----	0.0182	----	----	----	----	0.0123	----	----	----	
	Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

1 - Pre-Existing Condition measurement taken on existing sandbed riffle

Table 5 continued. Baseline Stream Summary																													
Thomas Creek Restoration Project: DMS Project ID No. 96074																													
Reach 4 - Length 1,238 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built						
											Thomas Creek Site Upper Reach 4 (On-site)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
Dimension and Substrate - Riffle																													
BF Width (ft)	----	11.6	11.9	----	----	----	----	4.5	----	----	----	----	----	----	----	----	----	6.3	----	----	----	----	----	----	6.8	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	9.9	----	----	----	----	----	----	----	----	----	>13	----	----	----	----	----	----	21.9	----	----	----	
BF Mean Depth (ft)	----	1.2	1.5	----	----	----	----	0.7	----	----	----	----	----	----	----	----	----	0.5	----	----	----	----	----	----	0.5	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	1.4	----	----	----	----	----	----	----	----	----	0.6	----	----	----	----	----	----	0.9	----	----	----	
BF Cross-sectional Area (ft ²)	----	----	3.1	----	----	----	----	3.1	----	----	----	----	----	----	----	----	----	3.1	----	----	----	----	----	----	3.6	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	6.4	----	----	10.0	----	----	14.0	----	----	----	12.0	----	----	14.0	----	----	----	12.7	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	2.2	----	----	----	----	>2.2	----	----	----	----	>2.1	----	----	----	----	----	----	3.2	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	3.0	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	----	1.0	----	----	----	
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pattern																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20.0	----	----	29.0	----	----	----	----	34.0	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12.0	----	----	18.0	----	----	----	----	16.9	----	----	----
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	2.0	----	----	3.0	----	----	----	2.0	----	----	3.0	----	----	----	----	2.5	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	60.0	----	----	75.0	----	----	----	----	66.2	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	3.5	----	----	8.0	----	----	----	3.2	----	----	4.6	----	----	----	----	5.0	----	----	----
Profile																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	15.4	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.029	----	----	----	----	0.035	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	28-	----	----	43	----	----	----	----	42.8	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.5	----	----	----	----	1.3	----	----	----
Pool Volume (ft ³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Substrate and Transport Parameters																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Additional Reach Parameters																													
Drainage Area (SM)	----	----	----	----	----	----	0.056	----	----	----	----	----	----	----	----	----	----	----	----	----	0.056	----	----	----	----	0.056	----	----	----
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	----	----	----	----	----	B5c	----	----	----	----	----	C5	----	----	----	----	----	----	----	C5	----	----	----	----	----	C5	----	----
BF Velocity (fps)	----	3.2	3.9	----	----	----	----	3.6	----	----	3.5	----	----	5	----	----	----	----	----	----	3.6	----	----	----	----	----	----	----	----
BF Discharge (cfs)	----	17.8	29.7	----	----	----	----	11.1	----	----	----	----	----	----	----	----	----	----	----	----	11.1	----	----	----	----	----	----	----	----
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	285.55	----	----	----
Channel length (ft)	----	----	----	----	----	----	----	1,197	----	----	----	----	----	----	----	----	----	----	----	----	1,201	----	----	----	----	342.91	----	----	----
Sinuosity	----	----	----	----	----	----	----	1.16	----	----	1.20	----	----	1.50	----	----	----	----	----	----	1.13	----	----	----	----	1.20	----	----	----
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	----	0.0121	----	----	----	----	----	----	----	----	----	----	----	----	0.015	----	----	----	----	0.0156	----	----	----
BF slope (ft/ft)	----	----	----	----	----	----	----	0.0105	----	----	0.005	----	----	0.015	----	----	----	----	----	----	0.024	----	----	----	----	0.0188	----	----	----
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Table 5 continued. Baseline Stream Summary																												
Thomas Creek Restoration Project: DMS Project ID No. 96074																												
Reach 5 - Length 1,169 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built					
											Little Beaver Creek (Wake County)																	
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	----	11.6	11.9	----	4.4	----	----	8.9	----	----	----	----	----	----	----	----	----	6.8	----	----	----	----	----	8.6	----	----	----	----
Floodprone Width (ft)	----	----	----	----	7.8	----	----	>30	----	----	----	----	----	----	----	----	----	>16	----	----	----	----	----	49.9	----	----	----	----
BF Mean Depth (ft)	----	1.2	1.5	----	0.4	----	----	1.0	----	----	----	----	----	----	----	----	----	0.5	----	----	----	----	----	0.9	----	----	----	----
BF Max Depth (ft)	----	----	----	----	0.8	----	----	1.6	----	----	----	----	----	----	----	----	----	0.7	----	----	----	----	----	1.2	----	----	----	----
BF Cross-sectional Area (ft²)	----	----	4.0	----	3.4	----	----	4.5	----	----	----	----	----	----	----	----	----	3.6	----	----	----	----	----	6.8	----	----	----	----
Width/Depth Ratio	----	----	----	----	4.2	----	----	3.4	----	----	10.0	----	----	14.0	----	----	----	13.0	----	----	----	----	----	8.4	----	----	----	----
Entrenchment Ratio	----	----	----	----	1.8	----	----	5.4	----	----	----	----	----	>2.2	----	----	----	>2.3	----	----	----	----	----	6.6	----	----	----	----
Bank Height Ratio	----	----	----	----	2.4	----	----	1.0	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	1.0	----	----	----	----
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pattern																												
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	28	----	----	45	----	----	----	58.6	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	14	----	----	20	----	----	----	17.5	----	----	----	----
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2	----	----	3	----	----	----	2.0	----	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	60	----	----	90	----	----	----	81.5	----	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	3.5	----	----	8	----	----	4.1	----	----	6.6	----	----	----	6.8	----	----	----	----
Profile																												
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	15.2	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.0265	----	----	----	----	----	0.0196	----	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	25	----	----	55	----	----	----	57.8	----	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.3	----	----	----	----	----	1.7	----	----	----	----
Pool Volume (ft³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	17.6 / 36.9 / 53.7 / 130.6 / 184.8	----	----	----	----
Reach Shear Stress (competency) lb/ft²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Additional Reach Parameters																												
Drainage Area (SM)	----	----	----	----	0.097	----	----	0.083	----	----	----	----	----	----	----	----	----	----	0.097	----	----	----	----	0.097	----	----	----	----
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	----	----	----	B5c	----	----	C	----	----	----	----	C5	----	----	----	----	----	----	C5	----	----	----	----	E5	----	----	----
BF Velocity (fps)	----	3.4	3.7	----	3.7	----	----	4.2	----	----	3.5	----	----	5	----	----	----	----	----	3.3	----	----	----	----	----	----	----	----
BF Discharge (cfs)	----	9.4	14.7	----	14.4	----	----	16.5	----	----	----	----	----	----	----	----	----	----	----	12.0	----	----	----	----	----	----	----	----
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	726.02	----	----	----	----
Channel length (ft)	----	----	----	----	----	----	----	1,022	----	----	----	----	----	----	----	----	----	----	----	1,828	----	----	----	1069.32	----	----	----	----
Sinuosity	----	----	----	----	1.31	----	----	1.42	----	----	1.20	----	----	1.50	----	----	----	----	----	1.42	----	----	----	1.47	----	----	----	----
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	----	0.0177	----	----	----	----	----	----	----	----	----	----	----	0.0124	----	----	----	0.0123	----	----	----	----
BF slope (ft/ft)	----	----	----	----	----	----	----	0.0133	----	----	0.005	----	----	0.015	----	----	----	----	----	0.0134	----	----	----	0.0185	----	----	----	----
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1 - As-Built measurements taken from constructed rock riffle																												

Table 5 continued. Baseline Stream Summary																													
Thomas Creek Restoration Project: DMS Project ID No. 96074																													
Reach 6 - Length 1,776 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built						
											Thomas Creek Site Upper Reach 4 (On-site)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
Dimension and Substrate - Riffle																													
BF Width (ft)	----	----	----	----	3.2	----	----	4.3	----	----	----	----	----	----	----	----	----	4.6	----	----	----	----	----	6.3	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	4.5	----	----	6.5	----	----	----	----	----	----	----	----	----	>9	----	----	----	----	----	19.4	----	----	----	----	
BF Mean Depth (ft)	----	----	----	----	----	----	----	0.60	----	----	----	----	----	----	----	----	----	0.3	----	----	----	----	----	0.3	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	0.9	----	----	----	----	----	----	----	----	----	0.4	----	----	----	----	----	0.6	----	----	----	----	
BF Cross-sectional Area (ft²)	----	----	----	----	1.8	----	----	2.5	----	----	----	----	----	----	----	----	----	1.5	----	----	----	----	----	2.1	----	----	----	----	
Width/Depth Ratio	----	----	----	----	0.9	----	----	5.8	----	----	12.0	----	----	18.0	----	----	----	14.0	----	----	----	----	----	18.7	----	----	----	----	
Entrenchment Ratio	----	----	----	----	1.4	----	----	1.5	----	----	1.4	----	----	2.2	----	----	----	>2.0	----	----	----	----	----	3.1	----	----	----	----	
Bank Height Ratio	----	----	----	----	2.9	----	----	4.4	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	1.0	----	----	----	----	
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pattern																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Profile																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12.5	----	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.04	----	----	----	----	----	0.027	----	----	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	34.6	----	----	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0	----	----	----	----	----	1.2	----	----	----	----	----
Pool Volume (ft³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Substrate and Transport Parameters																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Additional Reach Parameters																													
Drainage Area (SM)	----	----	----	----	0.019	----	----	0.050	----	----	----	----	----	----	----	----	----	----	----	0.05	----	----	----	0.05	----	----	----	----	----
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	----	----	----	B5c	----	----	G5c	----	----	----	----	B5c	----	----	----	----	----	----	B5c	----	----	----	----	----	----	----	----	----
BF Velocity (fps)	----	----	----	----	2.8	----	----	4.1	----	----	4	----	----	6	----	----	----	----	----	3.3	----	----	----	----	----	----	----	----	----
BF Discharge (cfs)	----	----	----	----	5.1	----	----	10.2	----	----	----	----	----	----	----	----	----	----	----	12	----	----	----	----	----	----	----	----	----
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel length (ft)	----	----	----	----	----	----	----	1,828	----	----	----	----	----	----	----	----	----	----	----	1,808	----	----	----	----	----	----	----	----	----
Sinuosity	----	----	----	----	----	----	----	1.13	----	----	1.10	----	----	1.30	----	----	----	1.42	----	----	----	----	----	----	----	----	----	----	----
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	0.0148	----	----	0.0250	----	----	----	----	----	----	----	----	----	----	----	0.030	----	----	----	----	----	----	----	----	----
BF slope (ft/ft)	----	----	----	----	0.0250	----	----	0.0361	----	----	0.005	----	----	0.015	----	----	----	----	----	0.033	----	----	----	----	----	----	----	----	----
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Table 5 continued. Baseline Stream Summary																													
Thomas Creek Restoration Project: DMS Project ID No. 96074																													
Reach 7 - Length 647 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built						
											Thomas Creek Site Upper Reach 4 (On-site)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
Dimension and Substrate - Riffle																													
BF Width (ft)	----	----	----	----	----	----	----	3.6	----	----	----	----	----	----	----	----	----	4.6	----	----	----	----	----	----	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	5.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BF Mean Depth (ft)	----	----	----	----	----	----	----	0.4	----	----	----	----	----	----	----	----	----	0.3	----	----	----	----	----	----	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	0.6	----	----	----	----	----	----	----	----	----	0.4	----	----	----	----	----	----	----	----	----	----	
BF Cross-sectional Area (ft ²)	----	----	----	----	----	----	----	1.6	----	----	----	----	----	----	----	----	----	1.5	----	----	----	----	----	----	----	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	8.4	----	----	12.0	----	----	18.0	----	----	----	14.0	----	----	----	----	----	----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	1.5	----	----	1.4	----	----	2.2	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	4.2	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	----	----	----	----	----	
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pattern																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Profile																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0	----	----	----	----	----	----	----	----	----	----	----
Pool Volume (ft ³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Substrate and Transport Parameters																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
¹ d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	.012 / 0.29 / 0.43 / 0.87 / 1.39	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Additional Reach Parameters																													
Drainage Area (SM)	----	----	----	----	----	----	0.022	----	----	----	----	----	----	----	----	----	----	0.022	----	----	----	----	----	----	----	0.022	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification	----	----	----	----	----	----	B5	----	----	----	----	----	B5c	----	----	----	----	B5c	----	----	----	----	----	----	----	----	----	----	
BF Velocity (fps)	----	----	----	----	----	3.6	----	----	----	----	4	----	----	6	----	----	----	3.33	----	----	----	----	----	----	----	----	----	----	
BF Discharge (cfs)	----	----	----	----	----	----	5.7	----	----	----	----	----	----	----	----	----	----	5	----	----	----	----	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel length (ft)	----	----	----	----	----	----	646	----	----	----	----	----	----	----	----	----	----	646	----	----	----	----	----	----	----	----	----	----	
Sinuosity	----	----	----	----	----	1.11	----	----	----	----	1.10	----	----	1.30	----	----	----	1.11	----	----	----	----	----	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	0.025	----	----	----	----	----	----	----	----	----	----	----	0.032	----	----	----	----	----	----	----	----	----	----	
BF slope (ft/ft)	----	----	----	----	----	0.036	----	----	----	----	0.005	----	----	0.015	----	----	----	0.036	----	----	----	----	----	----	----	----	----	----	
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

1 - Pre-Existing Condition measurement taken on existing sandbed riffle

Table 5 continued. Baseline Stream Summary																																
Thomas Creek Restoration Project: DMS Project ID No. 96074																																
Reach T1 - Length 227 ft																																
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design						As-built									
											Thomas Creek Site Upper Reach 4 (On-site)																					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n				
Dimension and Substrate - Riffle																																
BF Width (ft)	----	----	----	----	----	----	----	7.2	----	----	----	----	----	----	----	----	----	7.0	----	----	----	----	----	----	8.5	----	----	----				
Floodprone Width (ft)	----	----	----	----	----	----	----	10.8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	30.6	----	----	----	----			
BF Mean Depth (ft)	----	----	----	----	----	----	----	0.4	----	----	----	----	----	----	----	----	----	0.6	----	----	----	----	----	----	0.6	----	----	----	----			
BF Max Depth (ft)	----	----	----	----	----	----	----	0.7	----	----	----	----	----	----	----	----	----	0.7	----	----	----	----	----	----	0.9	----	----	----	----			
BF Cross-sectional Area (ft ²)	----	----	----	----	----	----	----	2.8	----	----	----	----	----	----	----	----	----	3.8	----	----	----	----	----	----	5.3	----	----	----	----			
Width/Depth Ratio	----	----	----	----	----	----	----	18.6	----	----	12.0	----	----	18.0	----	----	----	13.0	----	----	----	----	----	----	13.6	----	----	----	----			
Entrenchment Ratio	----	----	----	----	----	----	----	1.5	----	----	1.4	----	----	2.2	----	----	----	----	----	----	----	----	----	----	3.6	----	----	----	----			
Bank Height Ratio	----	----	----	----	----	----	----	2.6	----	----	1.0	----	----	1.1	----	----	----	1.0	----	----	----	----	----	----	1.0	----	----	----	----			
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Pattern																																
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	32.5	----	----	----	----	----		
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.5	----	----	----	18.0	----	----	----	14.0	----	----	----	----	----		
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	2.0	----	----	2.6	----	----	----	----	----	----	----	----	----	----	1.7	----	----	----	----	----		
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	48.0	----	----	----	----	----		
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3.8	----	----	----	----	----		
Profile																																
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	14.7	----	----	----	----	----		
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.0135	----	----	----	----	----	----	----	0.0113	----	----	----	----	----		
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	25	----	----	42	----	----	----	----	----	----	----	----	----	----	41.2	----	----	----	----	----		
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.4	----	----	----	----	----	----	----	1.4	----	----	----	----	----		
Pool Volume (ft ³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Substrate and Transport Parameters																																
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Reach Shear Stress (competency) lb/ft ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Stream Power (transport capacity) W/m ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Additional Reach Parameters																																
Drainage Area (SM)	----	----	----	----	----	----	0.077	----	----	----	----	----	----	----	----	----	----	----	0.077	----	----	----	----	----	----	0.077	----	----	----	----		
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification	----	----	----	----	----	----	B5c	----	----	----	----	----	B5c	----	----	----	----	----	----	----	----	----	----	----	----	B5c	----	----	----	----	----	
BF Velocity (fps)	----	----	----	----	----	----	5.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3.66	----	----	----	----	----	----	
BF Discharge (cfs)	----	----	----	----	----	----	14.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.9	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel length (ft)	----	----	----	----	----	----	242	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	253	----	----	----	----	----	----	
Sinuosity	----	----	----	----	----	----	1.09	----	----	1.10	----	----	1.30	----	----	----	----	----	----	----	----	----	----	----	1.16	----	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0203	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	0.004	----	----	----	----	----	----	
BF slope (ft/ft)	----	----	----	----	----	----	0.0120	----	----	0.005	----	----	0.015	----	----	----	----	----	----	----	----	----	----	----	0.005	----	----	----	----	----	----	
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

Table 5 continued. Baseline Stream Summary																													
Thomas Creek Restoration Project: DMS Project ID No. 96074																													
Reach T2 - Length 157 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition							Reference Reach(es) Data						Design						As-built					
												Thomas Creek Site Upper Reach 4 (On-site)																	
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
Dimension and Substrate - Riffle																													
BF Width (ft)	----	----	----	----	----	----	----	2.1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	3.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BF Mean Depth (ft)	----	----	----	----	----	----	----	0.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	0.6	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BF Cross-sectional Area (ft ²)	----	----	----	----	----	----	----	0.8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	5.6	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	1.6	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	2.3	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
d50 (mm)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pattern																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rc:Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Profile																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool Volume (ft ³)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Substrate and Transport Parameters																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Reach Shear Stress (competency) lb/ft ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Stream Power (transport capacity) W/m ²	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Additional Reach Parameters																													
Drainage Area (SM)	----	----	----	----	----	----	0.008	----	----	----	----	----	----	----	----	----	----	0.008	----	----	----	----	----	----	----	0.008	----		
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Rosgen Classification	----	----	----	----	----	----	B5c	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BF Velocity (fps)	----	----	----	----	----	----	3.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BF Discharge (cfs)	----	----	----	----	----	----	2.7	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Channel length (ft)	----	----	----	----	----	----	171	----	----	----	----	----	----	----	----	----	----	158	----	----	----	----	----	----	----	----			
Sinuosity	----	----	----	----	----	----	1.17	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0414	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BF slope (ft/ft)	----	----	----	----	----	----	0.0417	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		

Table 6. Morphology and Hydraulic Monitoring Summary																												
Thomas Creek Restoration Project: DMS Project ID No. 96074																												
Stream Reach	Reach 3 (1,031 LF)																											
Dimension and substrate	Cross-section X-1 (Riffle)						Cross-section X-2 (Pool)						Cross-section X-3 (Riffle)															
Based on fixed baseline bankfull elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+							
BF Width (ft)	9.34							10.51							7.47													
BF Mean Depth (ft)	0.78							1.27							0.61													
Width/Depth Ratio	11.9							8.25							12.34													
BF Cross-sectional Area (ft²)	7.3							13.4							4.5													
BF Max Depth (ft)	1.29							2.06							0.89													
Width of Floodprone Area (ft)	55.3							61.3							37.3													
Entrenchment Ratio	5.9							5.8							5.0													
Bank Height Ratio	1							1							1													
Wetted Perimeter (ft)	10.9							13.1							8.7													
Hydraulic Radius (ft)	0.7							1.0							0.52													
Cross Sectional Area between end pins (ft²)	-							-							-													
d50 (mm)	-							-							-													
Stream Reach	Reach 4 (1,238 LF)						Reach 2 (2,126 LF)						Reach T1 (227 LF)															
Dimension and substrate	Cross-section X-4 (Riffle)						Cross-section X-5 (Riffle)						Cross-section X-6 (Riffle)						Cross-section X-7 (Riffle)									
Based on fixed baseline bankfull elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	6.78							10.42							10.15							8.46						
BF Mean Depth (ft)	0.53							0.71							1.01							0.62						
Width/Depth Ratio	12.7							14.77							10.08							13.64						
BF Cross-sectional Area (ft²)	3.6							7.4							10.2							5.3						
BF Max Depth (ft)	0.87							1.01							1.5							0.88						
Width of Floodprone Area (ft)	21.9							38.17							62.93							30.61						
Entrenchment Ratio	3.2							3.7							6.2							3.6						
Bank Height Ratio	1.0							1							1							1						
Wetted Perimeter (ft)	7.8							11.8							12.2							9.7						
Hydraulic Radius (ft)	0.5							0.6							0.8							0.5						
Cross Sectional Area between end pins (ft²)	-							-							-							-						
d50 (mm)	-							-							-							-						
Stream Reach	Reach 2 (2,126 LF)																											
Dimension and substrate	Cross-section X-8 (Pool)						Cross-section X-9 (Pool)						Cross-section X-10 (Riffle)															
Based on fixed baseline bankfull elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+							
BF Width (ft)	15.33							14.50							10.27													
BF Mean Depth (ft)	1.15							1.13							0.81													
Width/Depth Ratio	13.3							12.9							12.6													
BF Cross-sectional Area (ft²)	17.6							16.3							8.4													
BF Max Depth (ft)	2.70							2.15							1.18													
Width of Floodprone Area (ft)	53.1							70.6							74.5													
Entrenchment Ratio	3.5							4.9							7.2													
Bank Height Ratio	1.0							1.0							1.0													
Wetted Perimeter (ft)	17.6							16.8							11.9													
Hydraulic Radius (ft)	1.0							1.0							0.7													
Cross Sectional Area between end pins (ft²)	-							-							-													
d50 (mm)	-							-							-													

Table 6. Morphology and Hydraulic Monitoring Summary																					
Thomas Creek Restoration Project: DMS Project ID No. 96074																					
Stream Reach	Reach 1 (298 LF)												Reach 6 (1,776 LF)								
	Cross-section X-11 (Pool)						Cross-section X-12 (Riffle)						Cross-section X-13 (Riffle)								
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																					
BF Width (ft)	16.24							13.91							6.26						
BF Mean Depth (ft)	1.46							0.80							0.33						
Width/Depth Ratio	11.1							17.4							18.7						
BF Cross-sectional Area (ft ²)	23.7							11.1							2.1						
BF Max Depth (ft)	3.38							1.13							0.64						
Width of Floodprone Area (ft)	68.8							30.6							19.4						
Entrenchment Ratio	4.2							2.2							3.1						
Bank Height Ratio	1.0							1.0							1.0						
Wetted Perimeter (ft)	19.2							15.5							6.9						
Hydraulic Radius (ft)	1.2							0.7							0.3						
Cross Sectional Area between end pins (ft ²)	-							-							-						
d50 (mm)	-							-							-						
Stream Reach	Reach 5 (1,169 LF)																				
	Cross-section X-14 (Riffle)						Cross-section X-15 (Pool)						Cross-section X-16 (Pool)								
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																					
BF Width (ft)	7.52							10.30							9.34						
BF Mean Depth (ft)	0.90							0.75							0.78						
Width/Depth Ratio	8.4							13.8							11.9						
BF Cross-sectional Area (ft ²)	6.8							7.7							7.3						
BF Max Depth (ft)	1.24							1.45							1.29						
Width of Floodprone Area (ft)	49.9							59.6							63.8						
Entrenchment Ratio	6.6							5.8							5.9						
Bank Height Ratio	1.0							1.0							1.0						
Wetted Perimeter (ft)	9.3							11.8							10.9						
Hydraulic Radius (ft)	0.7							0.7							0.7						
Cross Sectional Area between end pins (ft ²)	-							-							-						
d50 (mm)	-							-							-						

Pebble Count; As-built Survey
Thomas Creek Mitigation Project, DMS# 96074

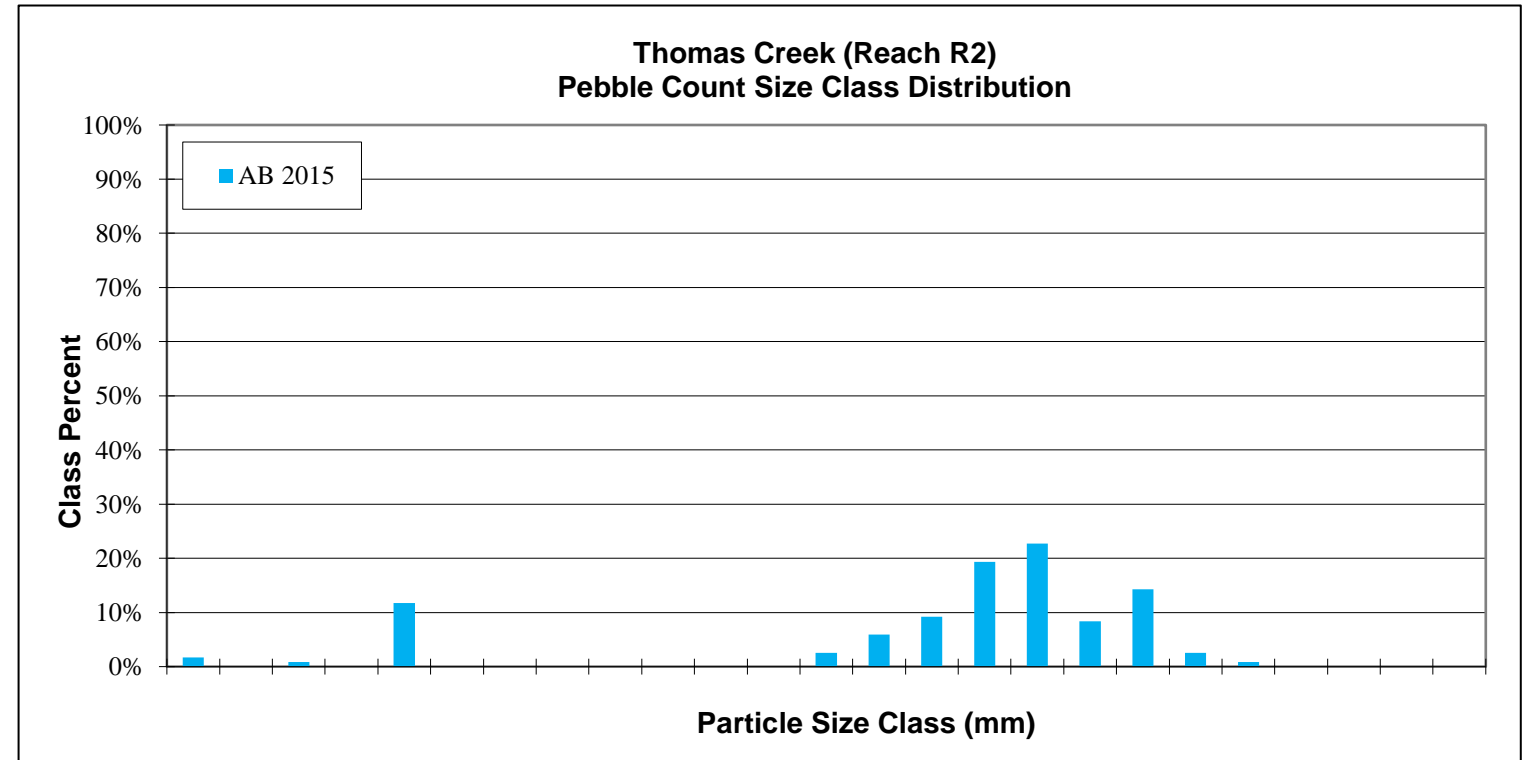
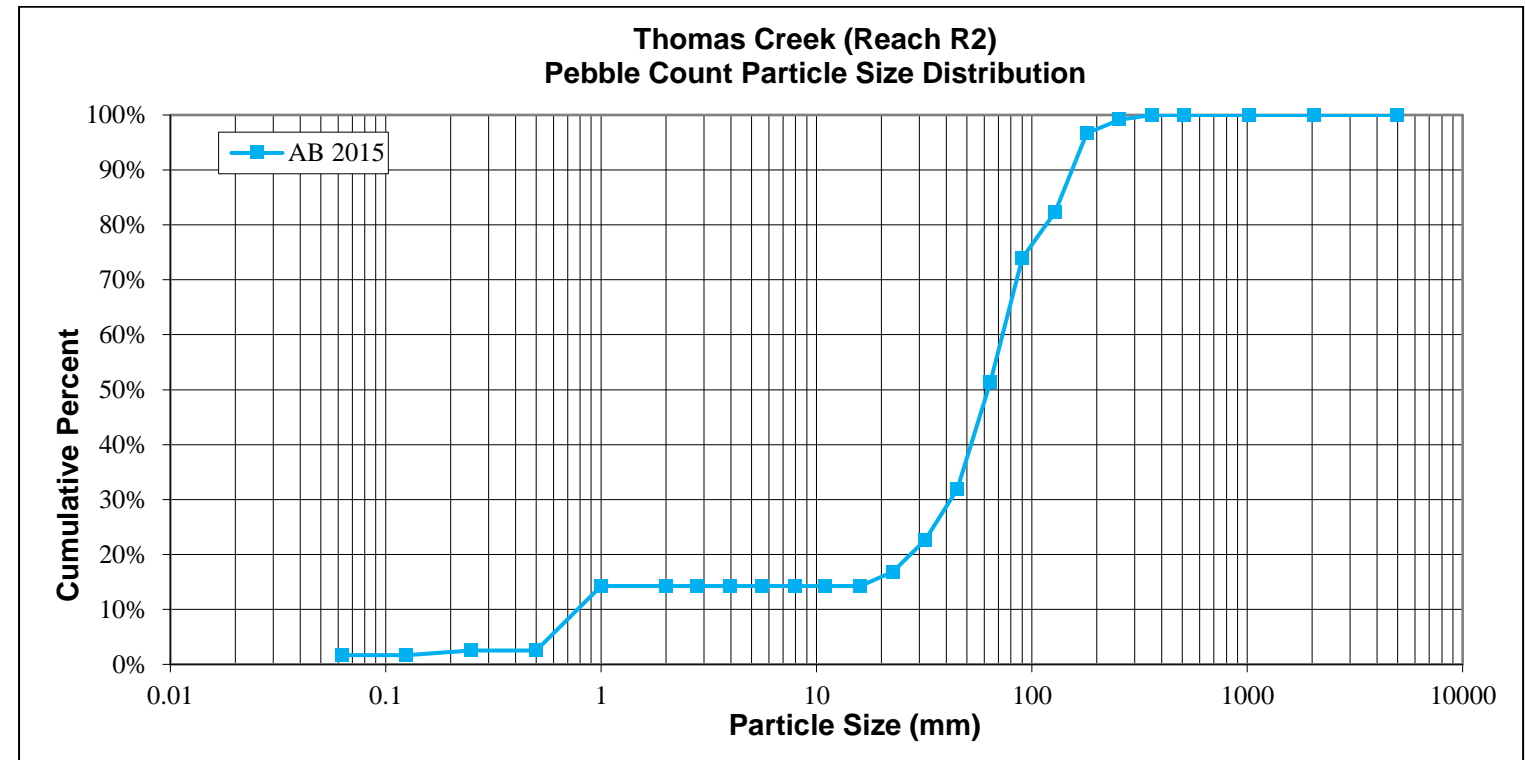
SITE OR PROJECT:	Thomas Creek
REACH/LOCATION:	Reach R2 (Station 37+00)
FEATURE:	Rock Riffle
DATE:	6-Nov-15

			AB 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063	2	2%	2%	0.063
Sand	Very Fine	.063 - .125			2%	0.125
	Fine	.125 - .25	1	1%	3%	0.25
	Medium	.25 - .50			3%	0.50
	Coarse	.50 - 1.0	14	12%	14%	1.0
	Very Coarse	1.0 - 2.0			14%	2.0
Gravel	Very Fine	2.0 - 2.8			14%	2.8
	Very Fine	2.8 - 4.0			14%	4.0
	Fine	4.0 - 5.6			14%	5.6
	Fine	5.6 - 8.0			14%	8.0
	Medium	8.0 - 11.0			14%	11.0
	Medium	11.0 - 16.0			14%	16.0
	Coarse	16 - 22.6	3	3%	17%	22.6
	Coarse	22.6 - 32	7	6%	23%	32
	Very Coarse	32 - 45	11	9%	32%	45
	Very Coarse	45 - 64	23	19%	51%	64
Cobble	Small	64 - 90	27	23%	74%	90
	Small	90 - 128	10	8%	82%	128
	Large	128 - 180	17	14%	97%	180
	Large	180 - 256	3	3%	99%	256
Boulder	Small	256 - 362	1	1%	100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			119	100%		

Largest particle=

362

Summary Data			
Channel materials			
D16 =	20.2	D84 =	133.1
D35 =	47.6	D95 =	173.1
D50 =	62.5	D100 =	256 - 362



Pebble Count; As-built Survey
Thomas Creek Mitigation Project, DMS# 96074

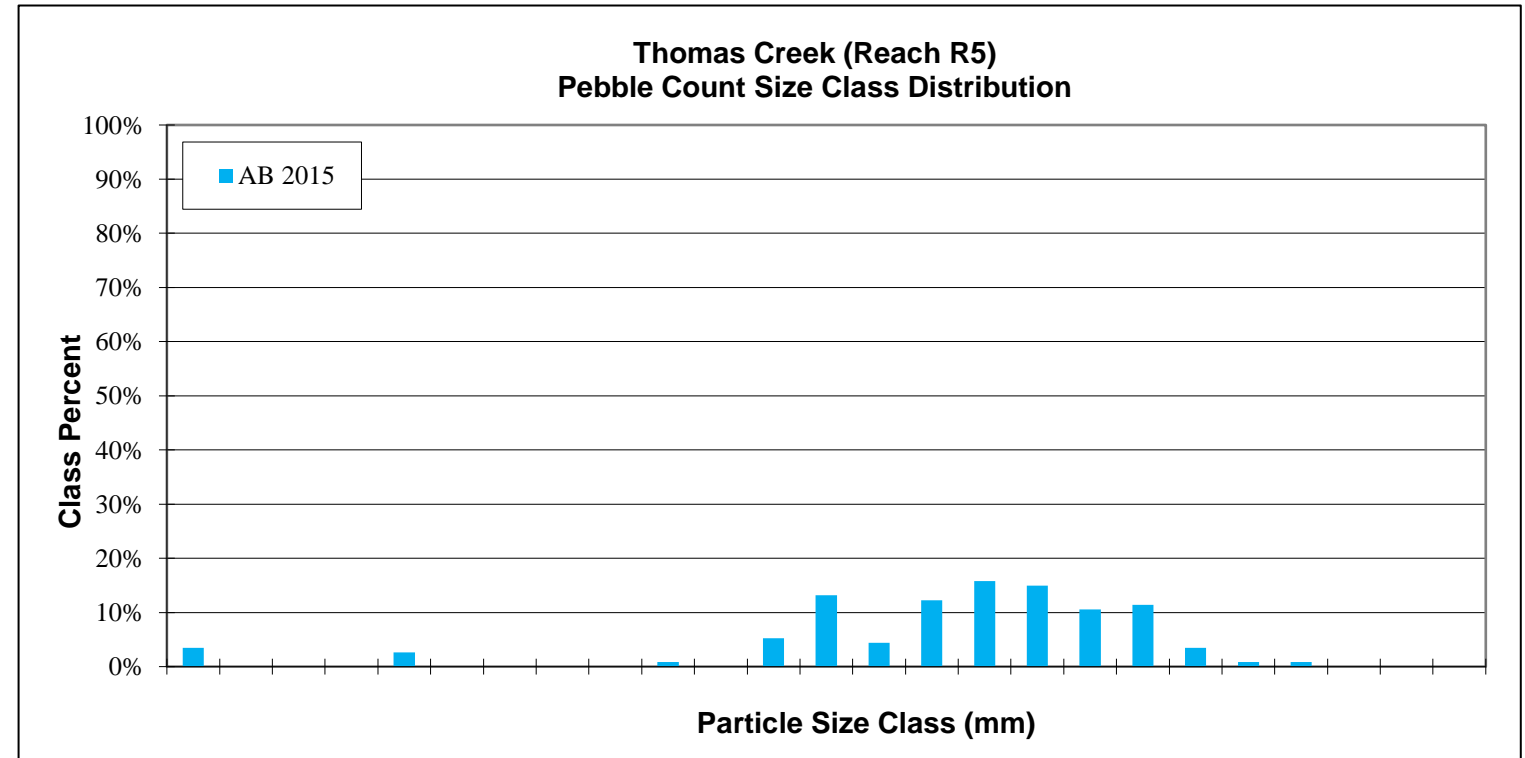
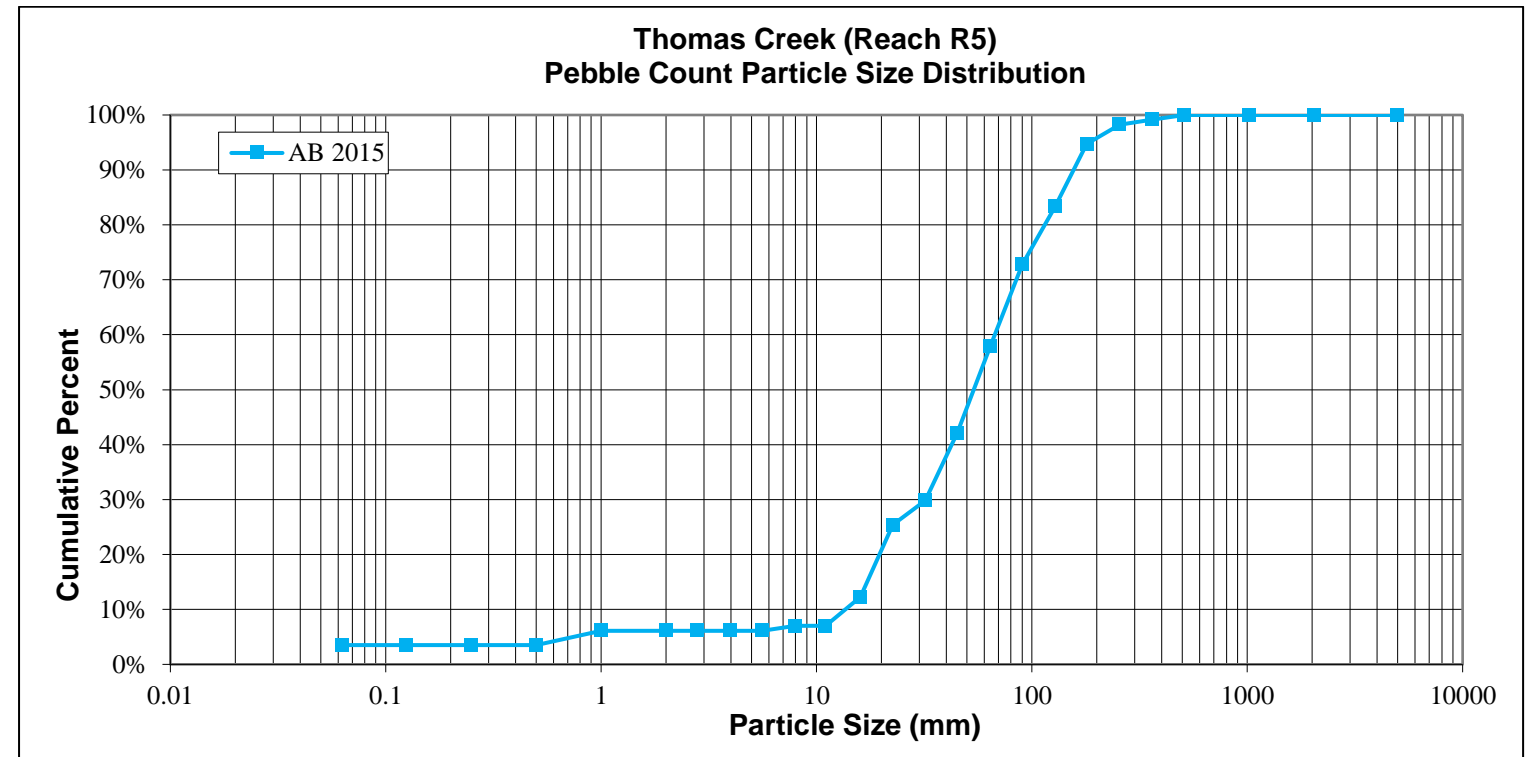
SITE OR PROJECT:	Thomas Creek
REACH/LOCATION:	Reach R5 (Station 37+00)
FEATURE:	Rock Riffle
DATE:	6-Nov-15

			AB 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063	4	4%	4%	0.063
Sand	Very Fine	.063 - .125			4%	0.125
	Fine	.125 - .25			4%	0.25
	Medium	.25 - .50			4%	0.50
	Coarse	.50 - 1.0	3	3%	6%	1.0
	Very Coarse	1.0 - 2.0			6%	2.0
Gravel	Very Fine	2.0 - 2.8			6%	2.8
	Very Fine	2.8 - 4.0			6%	4.0
	Fine	4.0 - 5.6			6%	5.6
	Fine	5.6 - 8.0	1	1%	7%	8.0
	Medium	8.0 - 11.0			7%	11.0
	Medium	11.0 - 16.0	6	5%	12%	16.0
	Coarse	16 - 22.6	15	13%	25%	22.6
	Coarse	22.6 - 32	5	4%	30%	32
	Very Coarse	32 - 45	14	12%	42%	45
	Very Coarse	45 - 64	18	16%	58%	64
Cobble	Small	64 - 90	17	15%	73%	90
	Small	90 - 128	12	11%	83%	128
	Large	128 - 180	13	11%	95%	180
	Large	180 - 256	4	4%	98%	256
Boulder	Small	256 - 362	1	1%	99%	362
	Small	362 - 512	1	1%	100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			114	100%		

Largest particle=

512

Summary Data			
Channel materials			
D16 =	17.6	D84 =	130.6
D35 =	36.9	D95 =	184.8
D50 =	53.7	D100 =	362 - 512



Permanent Cross-section 1
(As-Built Data - Collected Oct/Nov 2015)

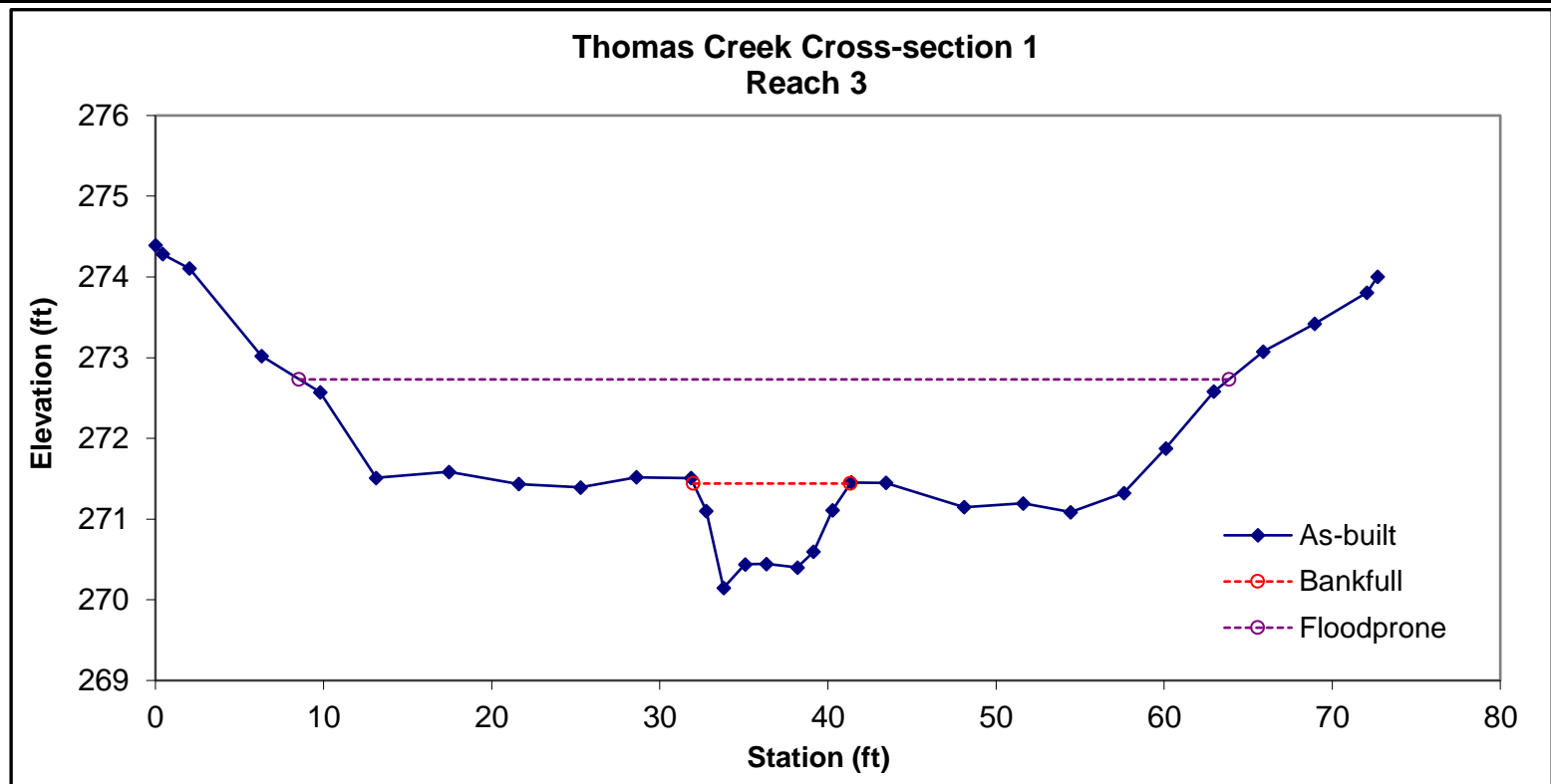


Looking at the Left Bank



Looking at the Right Bank

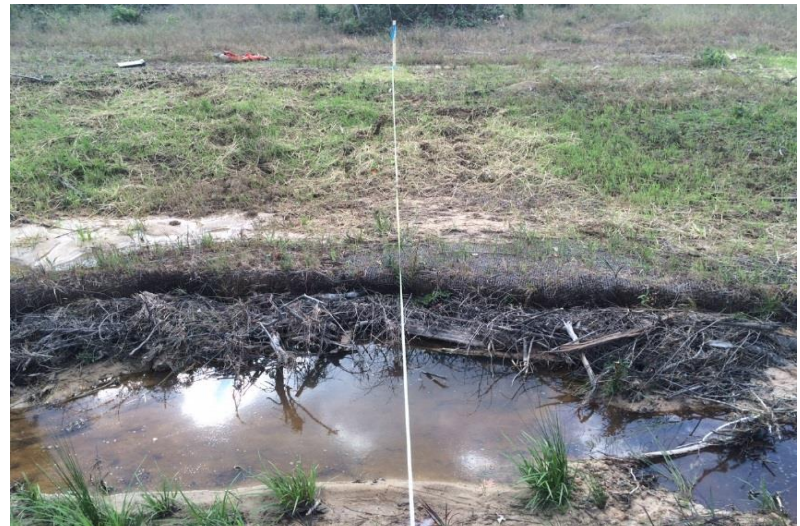
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	7.3	9.34	0.78	1.29	11.9	1	5.9	271.44	271.45



Permanent Cross-section 2
(As-Built Data - Collected Oct/Nov 2015)

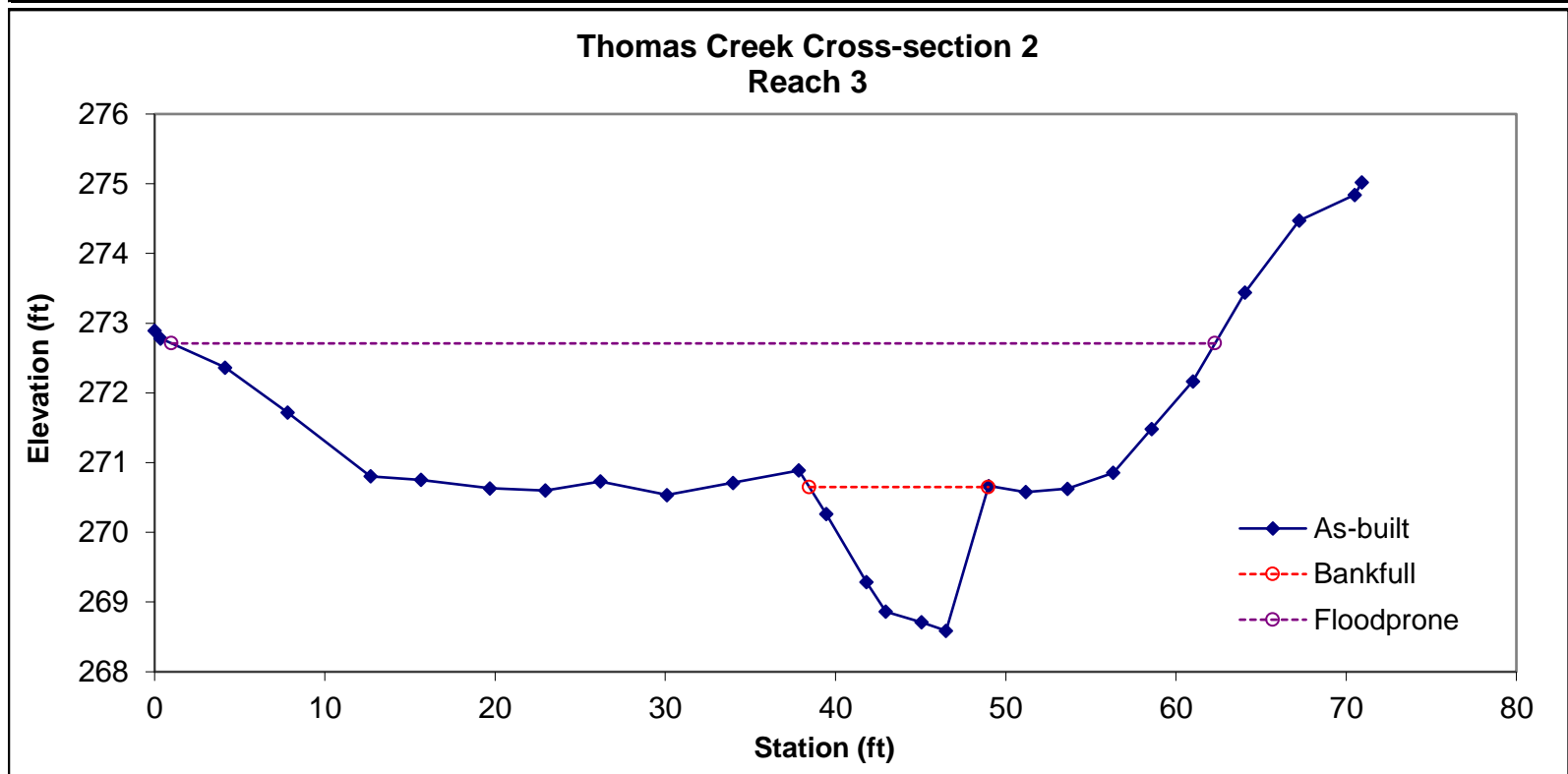


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		13.4	10.51	1.27	2.06	8.25	1	5.8	270.65	270.67



Permanent Cross-section 3
(As-Built Data - Collected Oct/Nov 2015)

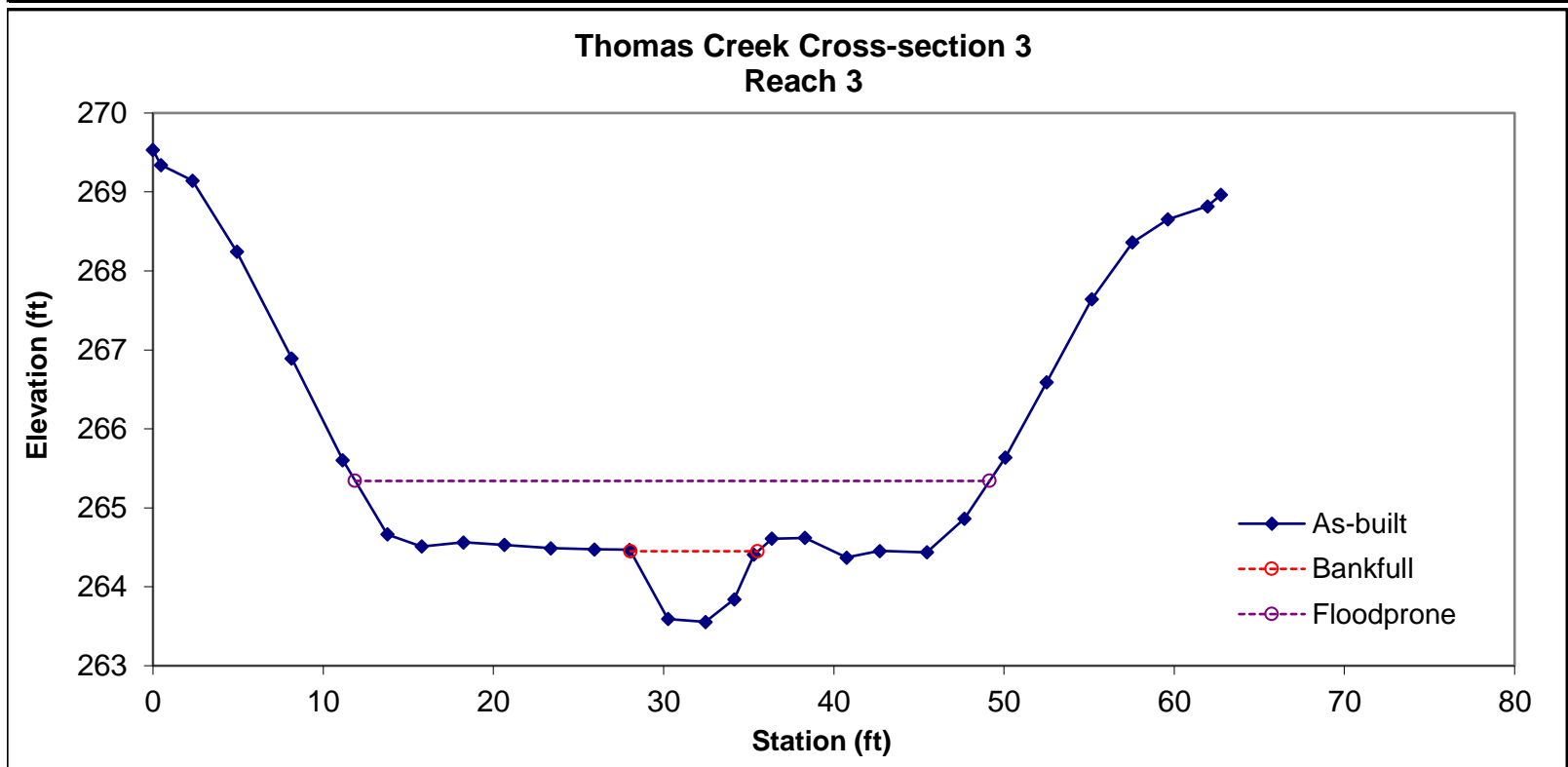


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	4.5	7.47	0.61	0.89	12.34	1	5	264.45	264.47



Permanent Cross-section 4
(As-Built Data - Collected Oct/Nov 2015)

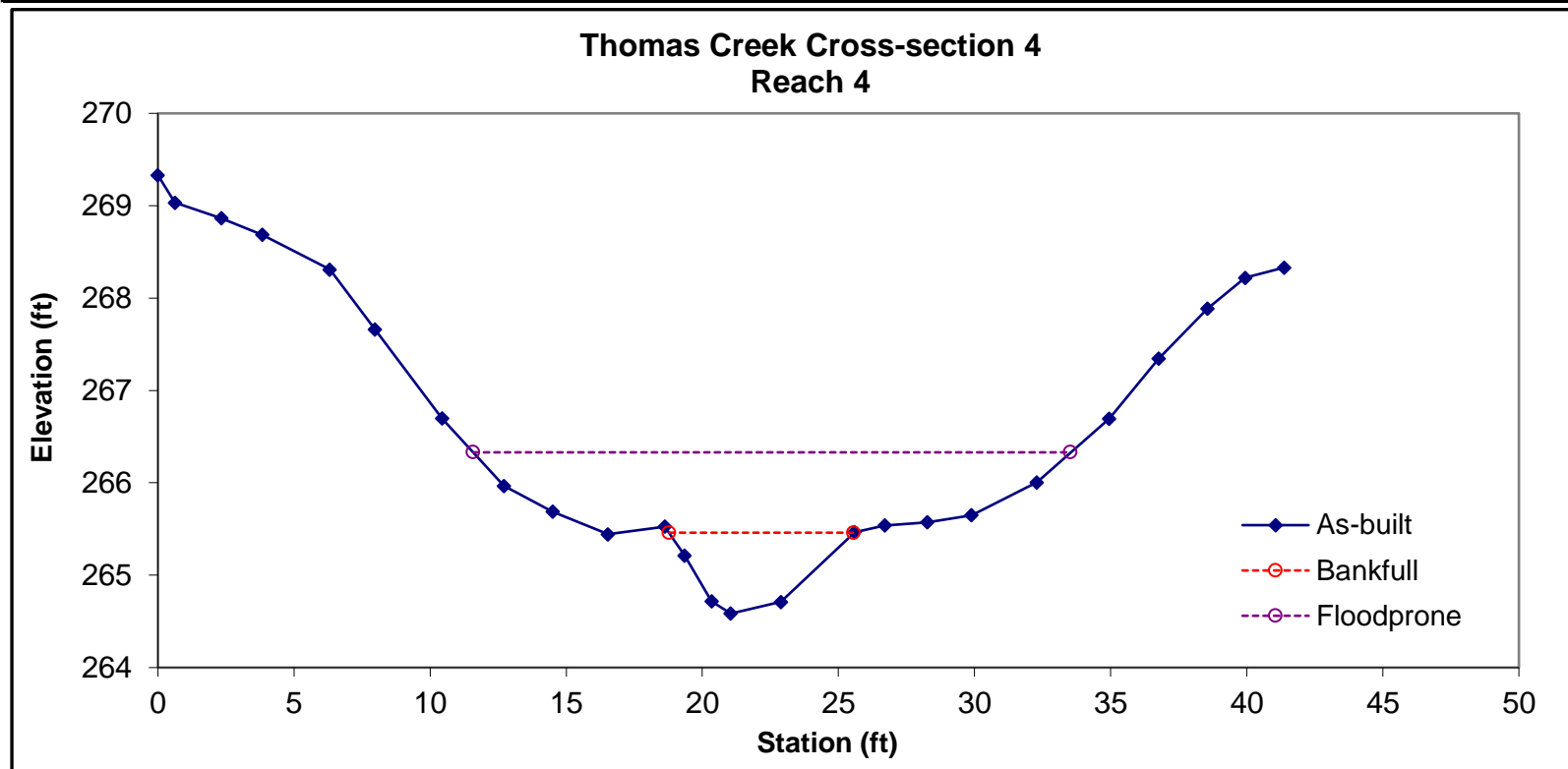


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	3.6	6.78	0.53	0.87	12.74	1	3.2	265.46	265.47



Permanent Cross-section 5
(As-Built Data - Collected Oct/Nov 2015)

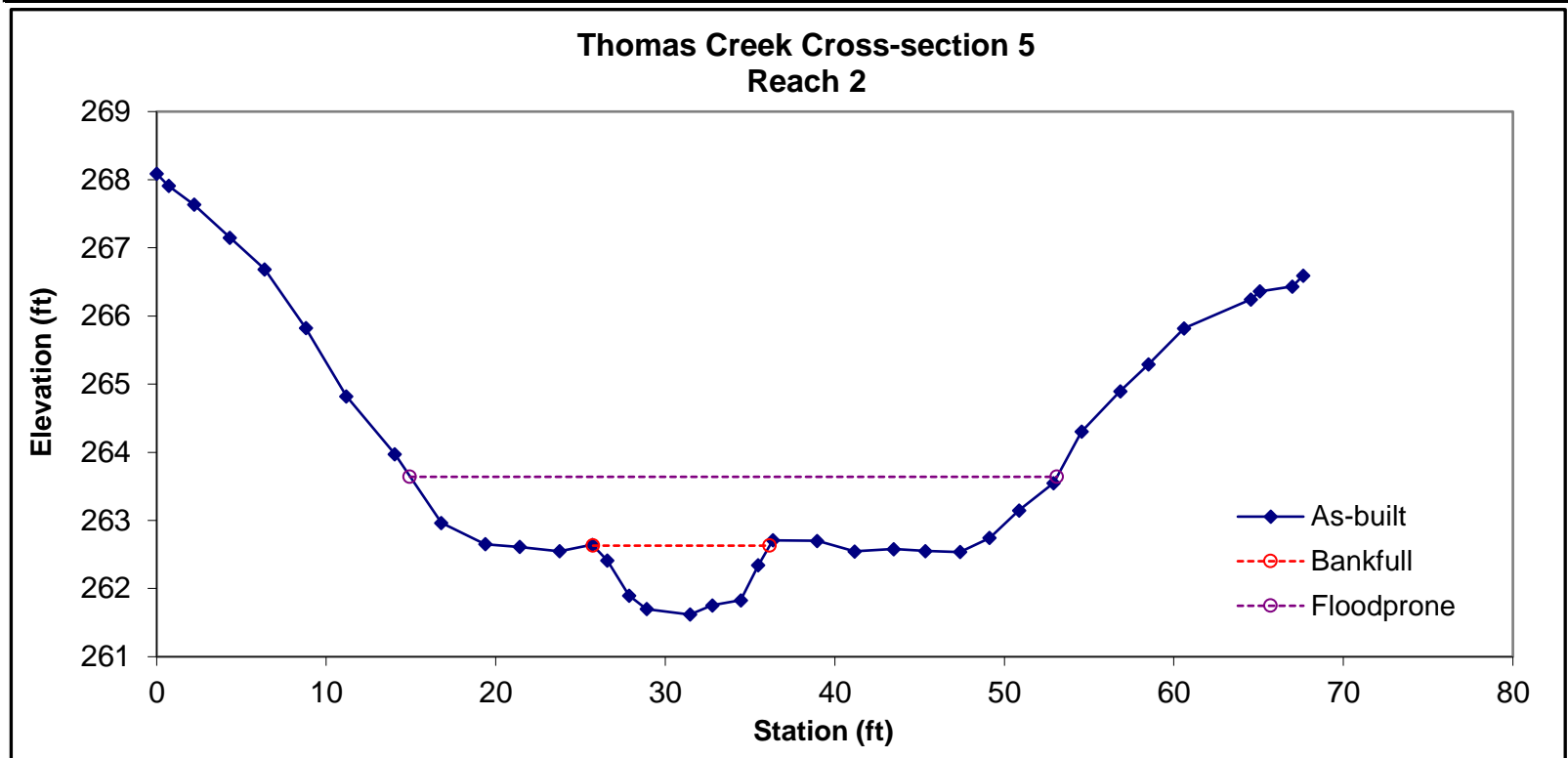


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	7.4	10.42	0.71	1.01	14.77	1	3.7	262.63	262.64



Permanent Cross-section 6
(As-Built Data - Collected Oct/Nov 2015)

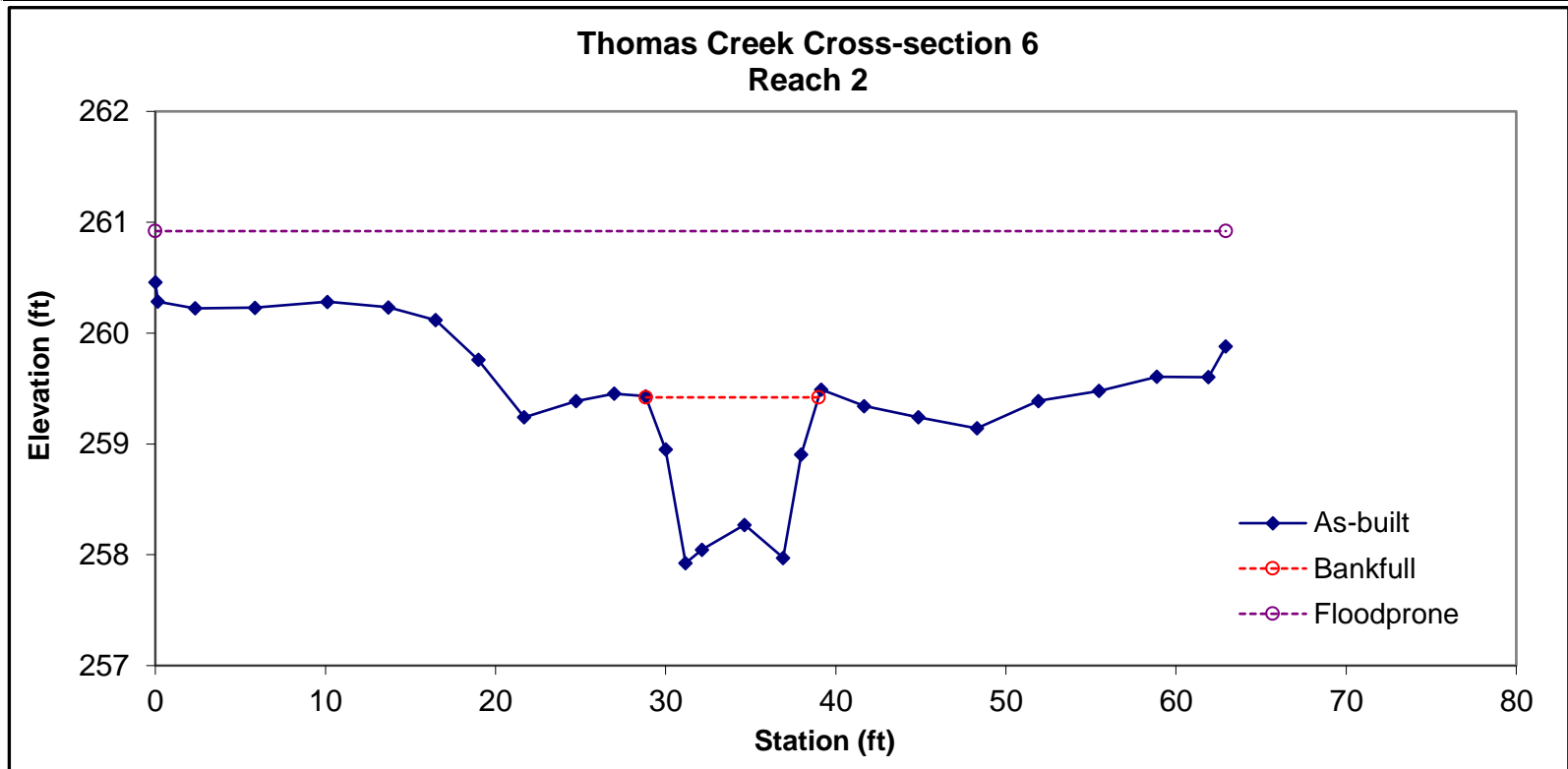


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	10.2	10.15	1.01	1.5	10.08	1	6.2	259.42	259.43



Permanent Cross-section 7
(As-Built Data - Collected Oct/Nov 2015)

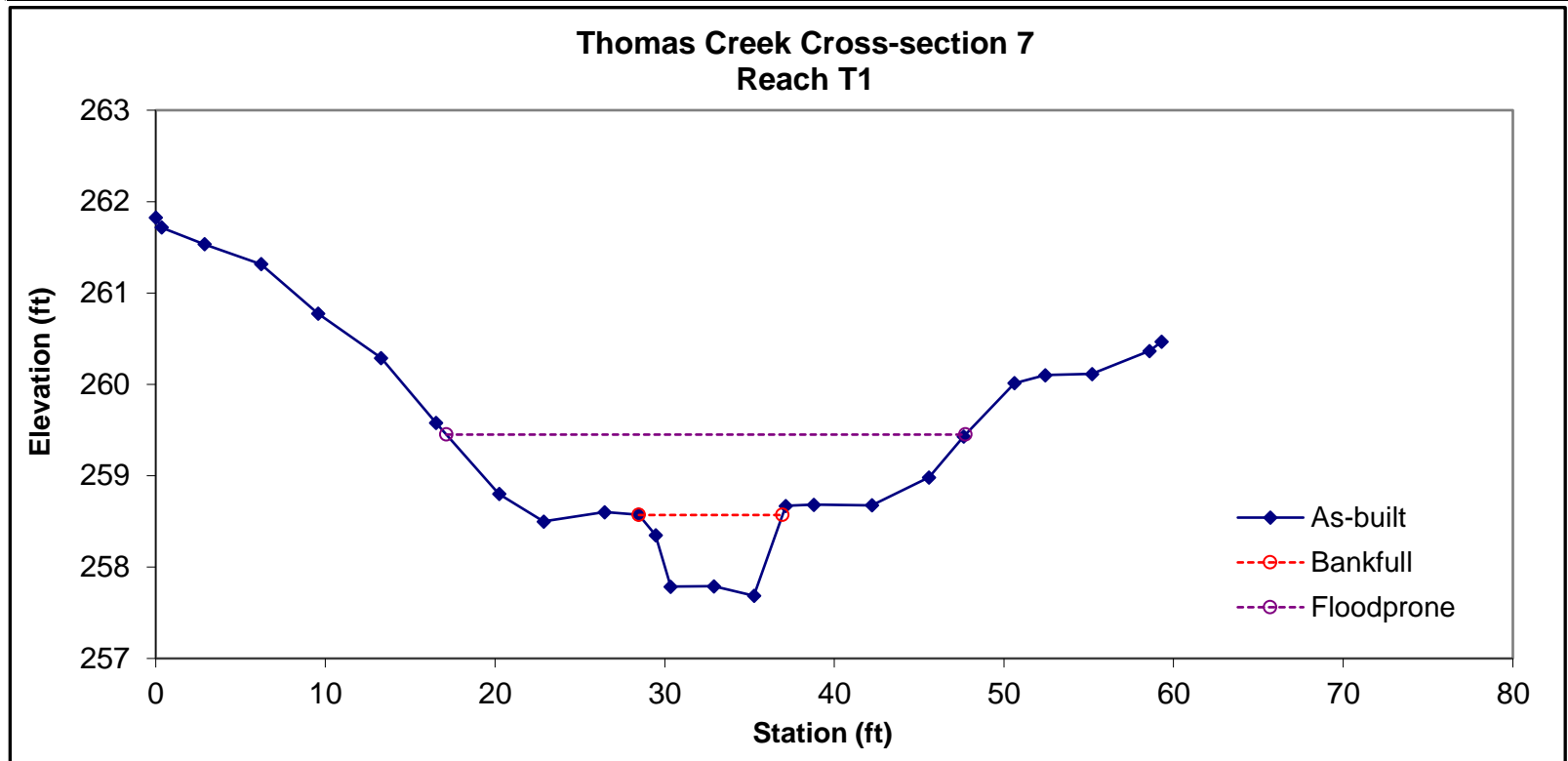


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	5.3	8.46	0.62	0.88	13.64	1	3.6	258.57	258.57



Permanent Cross-section 8
(As-Built Data - Collected Oct/Nov 2015)

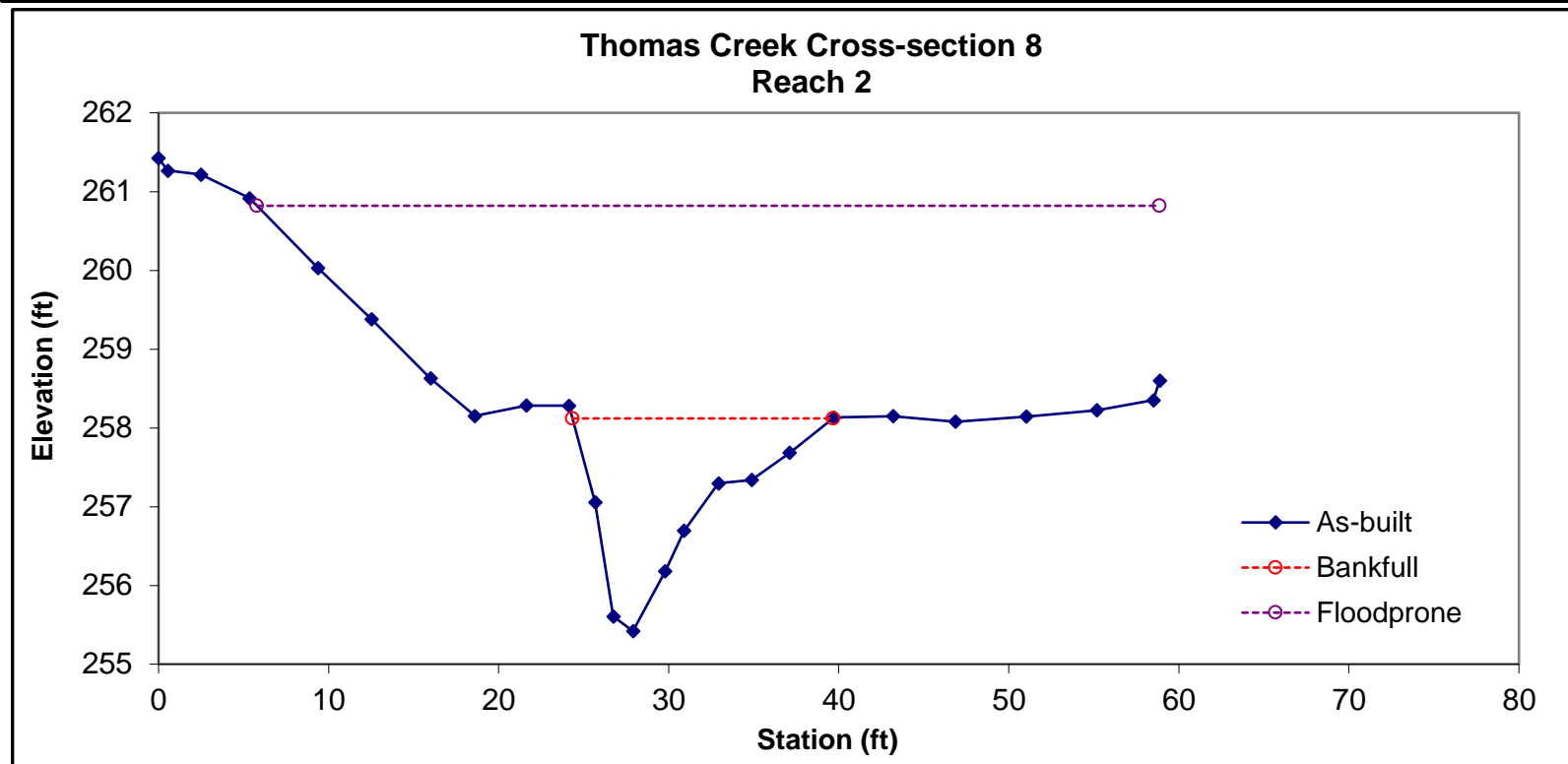


Looking at the Left Bank

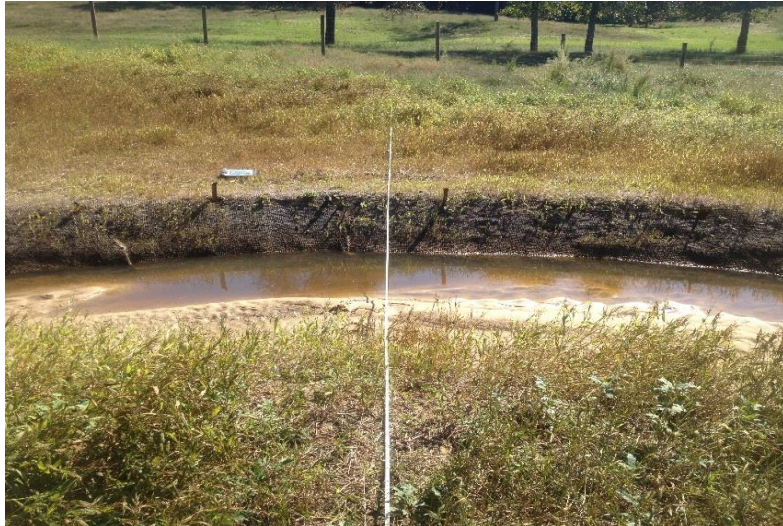


Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		17.6	15.33	1.15	2.7	13.32	1	3.5	258.12	258.13



Permanent Cross-section 9
(As-Built Data - Collected Oct/Nov 2015)

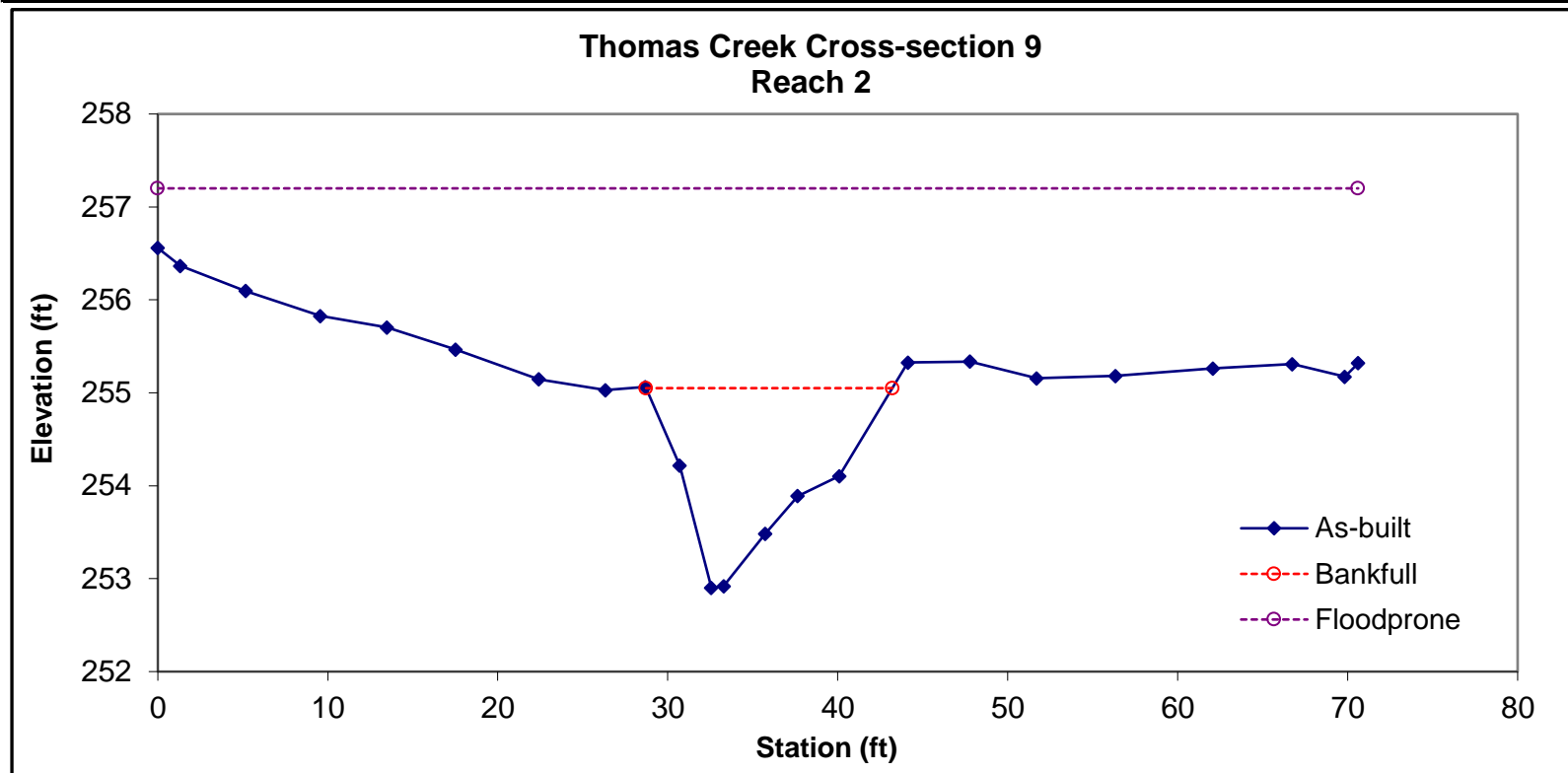


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		16.3	14.5	1.13	2.15	12.87	1	4.9	255.05	255.06



Permanent Cross-section 10
(As-Built Data - Collected Oct/Nov 2015)

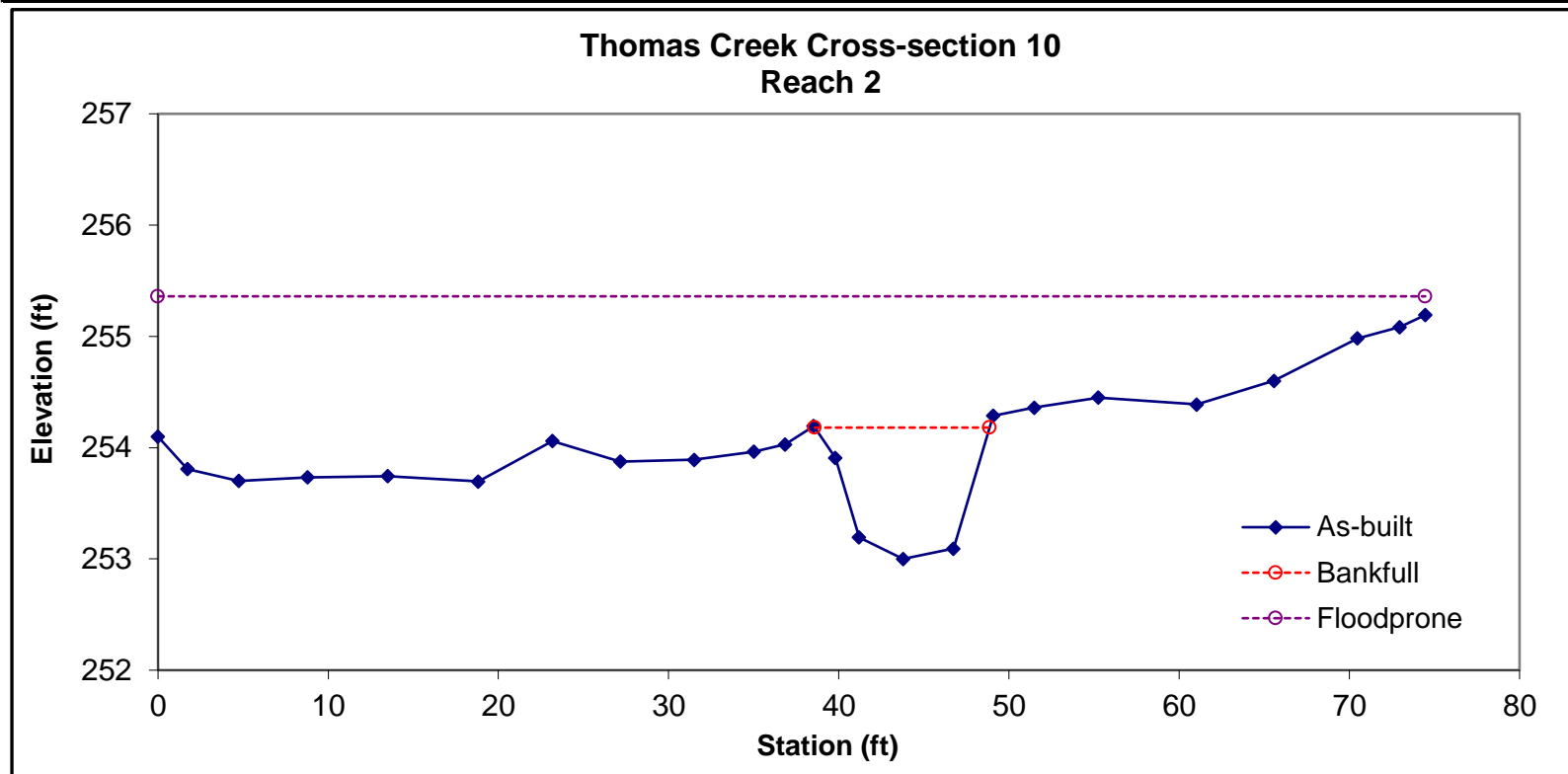


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	8.4	10.27	0.81	1.18	12.64	1	7.2	254.18	254.19



Permanent Cross-section 11
(As-Built Data - Collected Oct/Nov 2015)

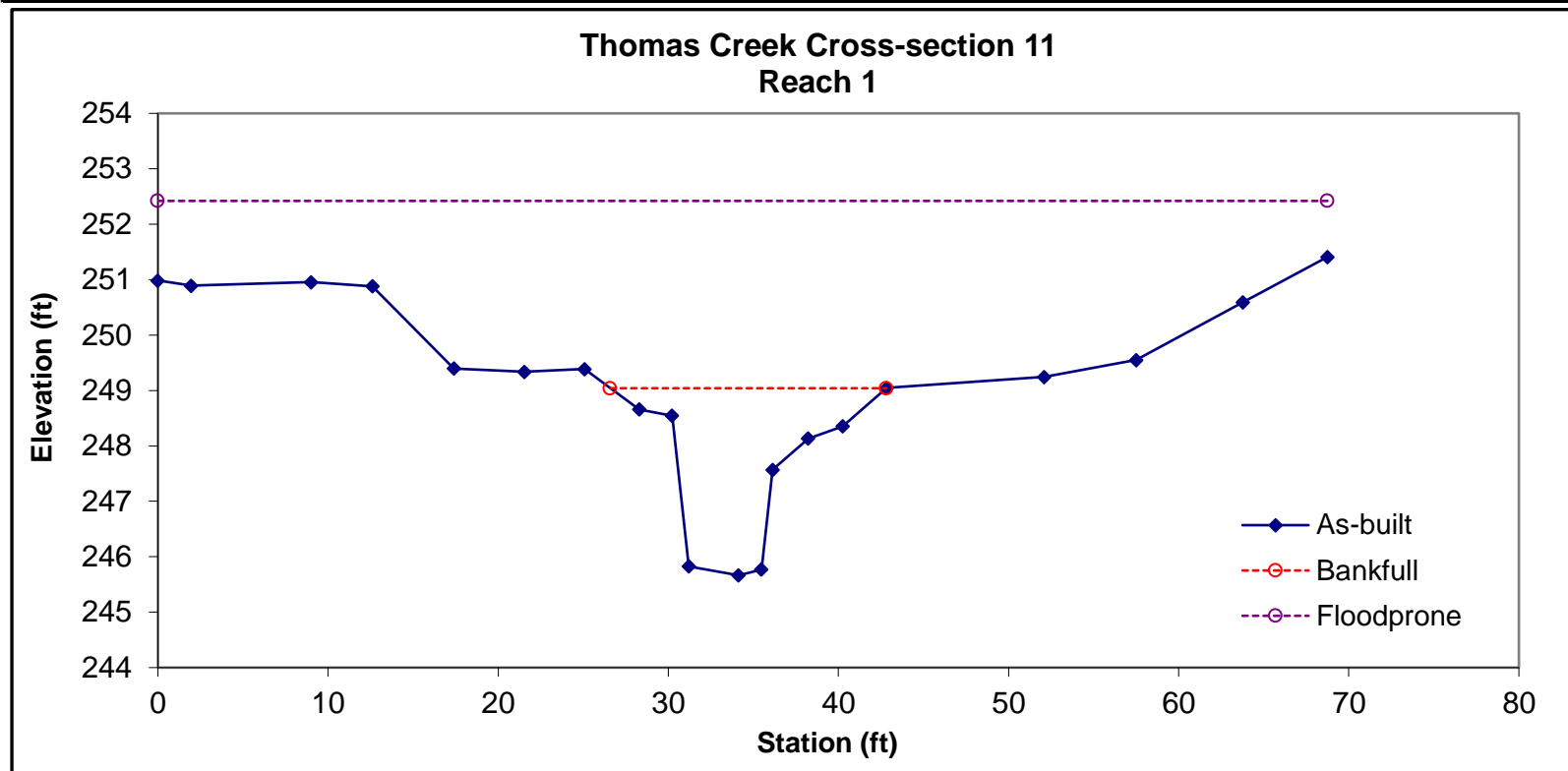


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		23.7	16.24	1.46	3.38	11.14	1	4.2	249.04	249.04



Permanent Cross-section 12
(As-Built Data - Collected Oct/Nov 2015)

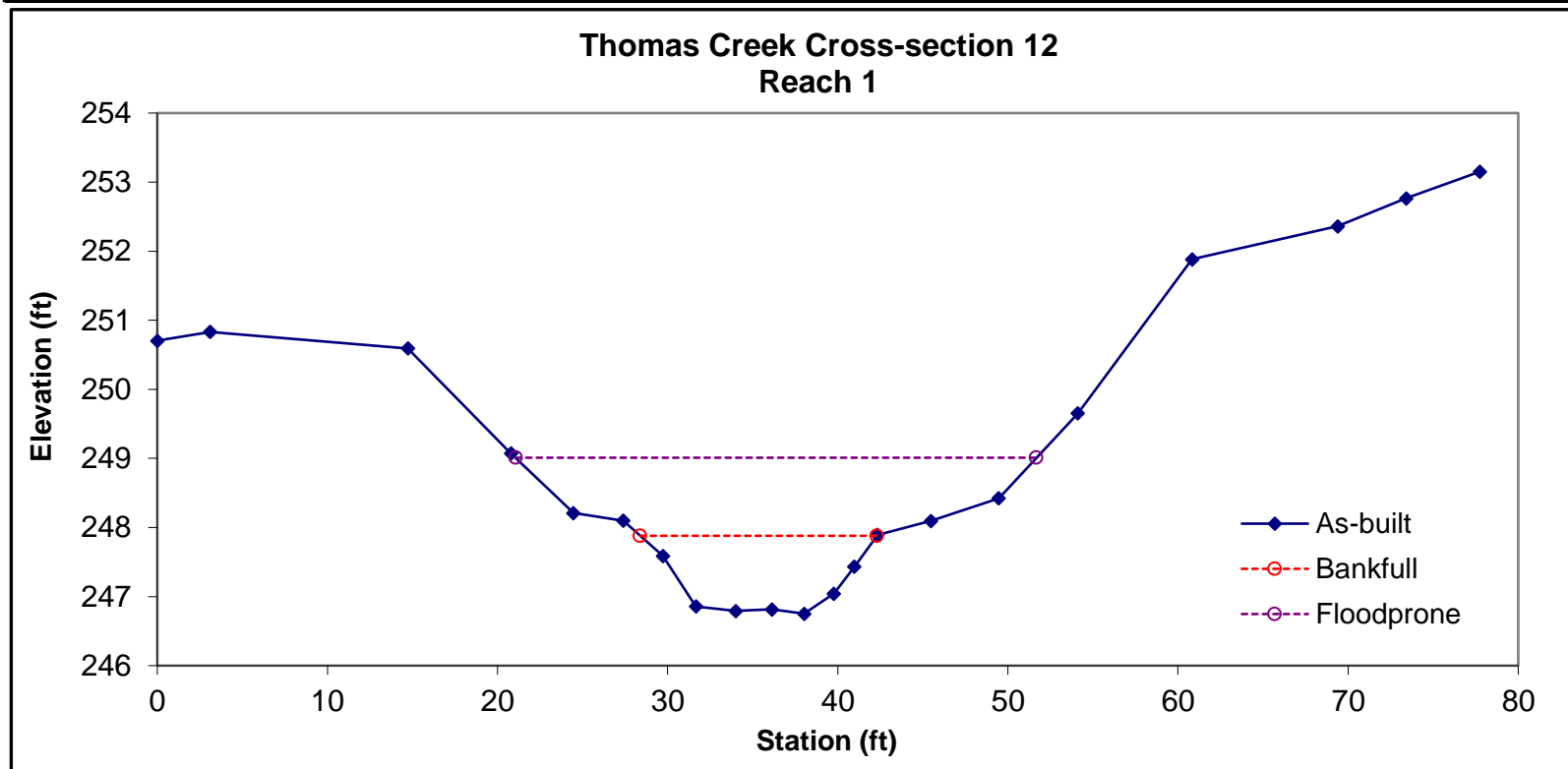


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	11.1	13.91	0.8	1.13	17.43	1	2.2	247.88	247.89



Permanent Cross-section 13
(As-Built Data - Collected Oct/Nov 2015)

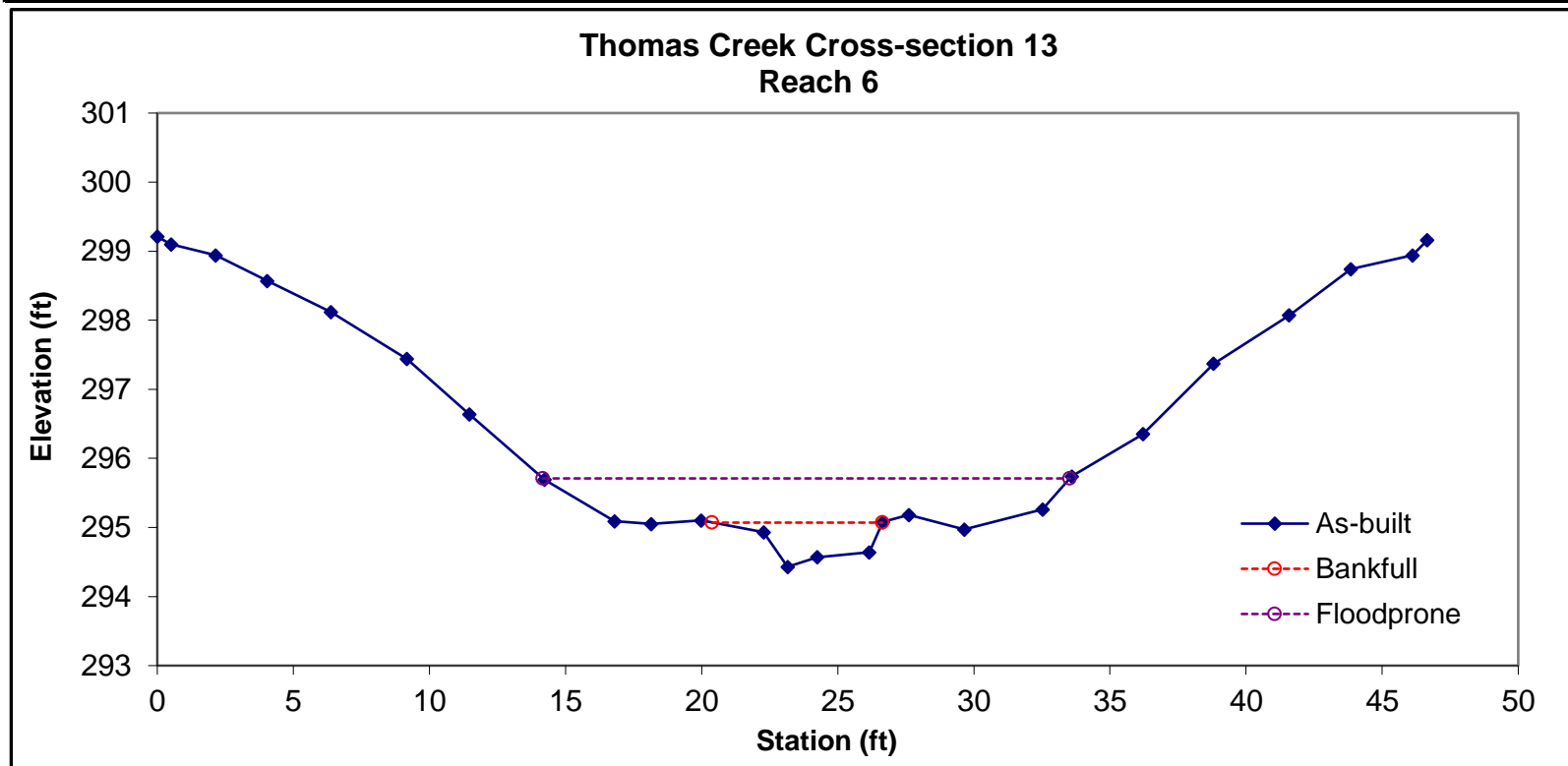


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	2.1	6.26	0.33	0.64	18.72	1	3.1	295.07	295.08



Permanent Cross-section 14
(As-Built Data - Collected Oct/Nov 2015)

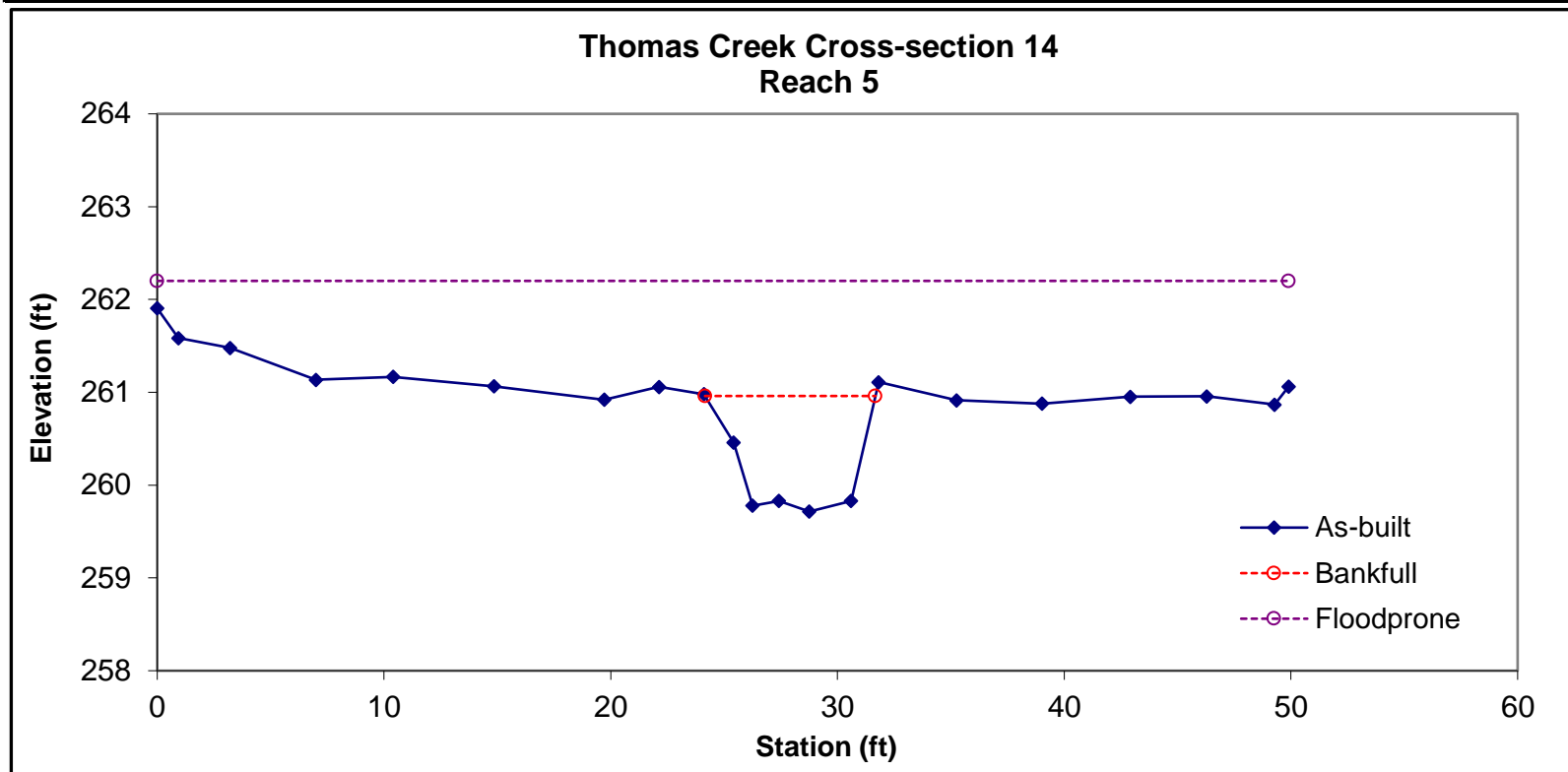


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	6.8	7.52	0.9	1.24	8.38	1	6.6	260.96	260.98



Permanent Cross-section 15
(As-Built Data - Collected Oct/Nov 2015)

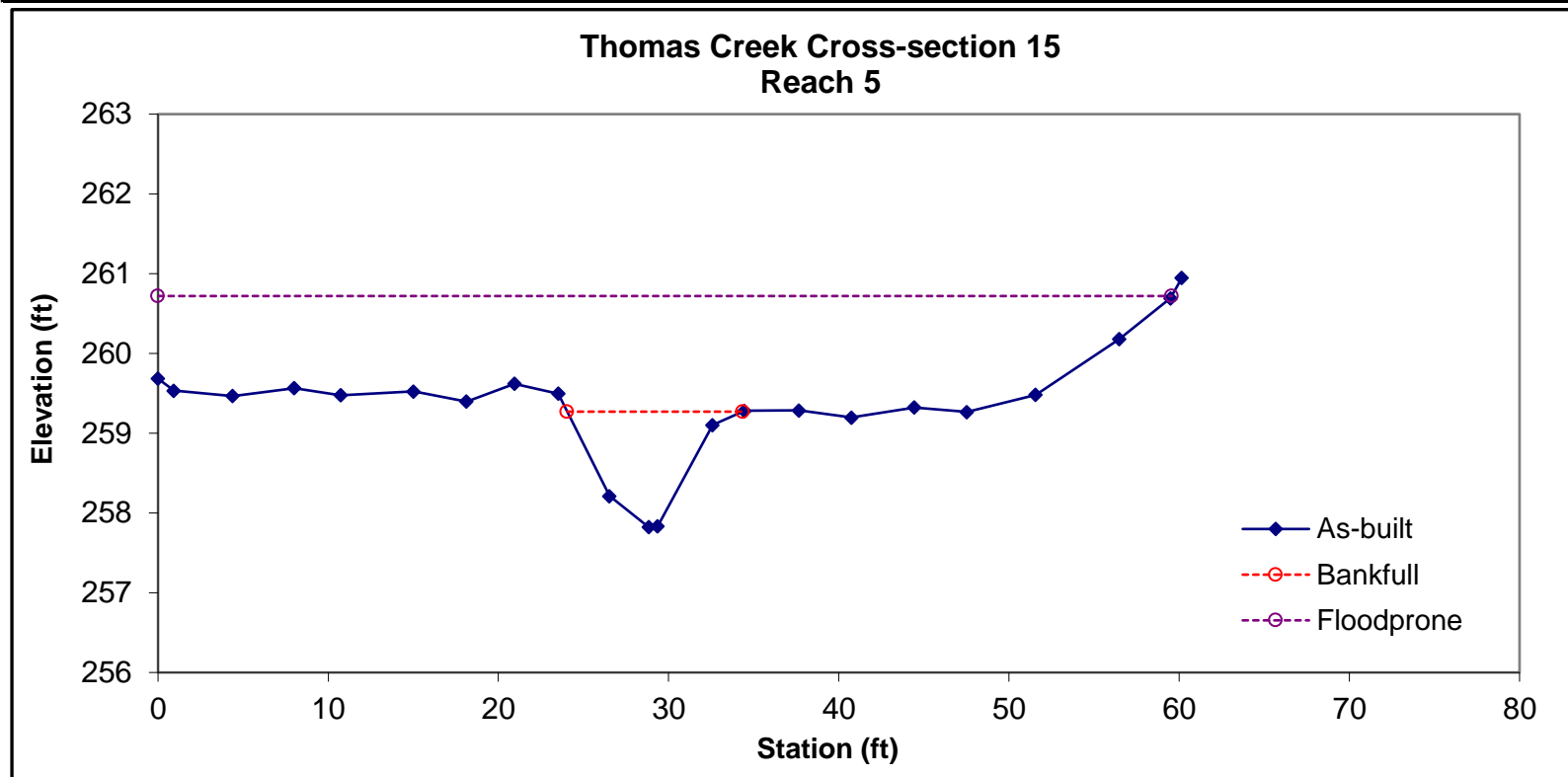


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		7.7	10.3	0.75	1.45	13.81	1	5.8	259.27	259.28



Permanent Cross-section 16
(As-Built Data - Collected Oct/Nov 2015)

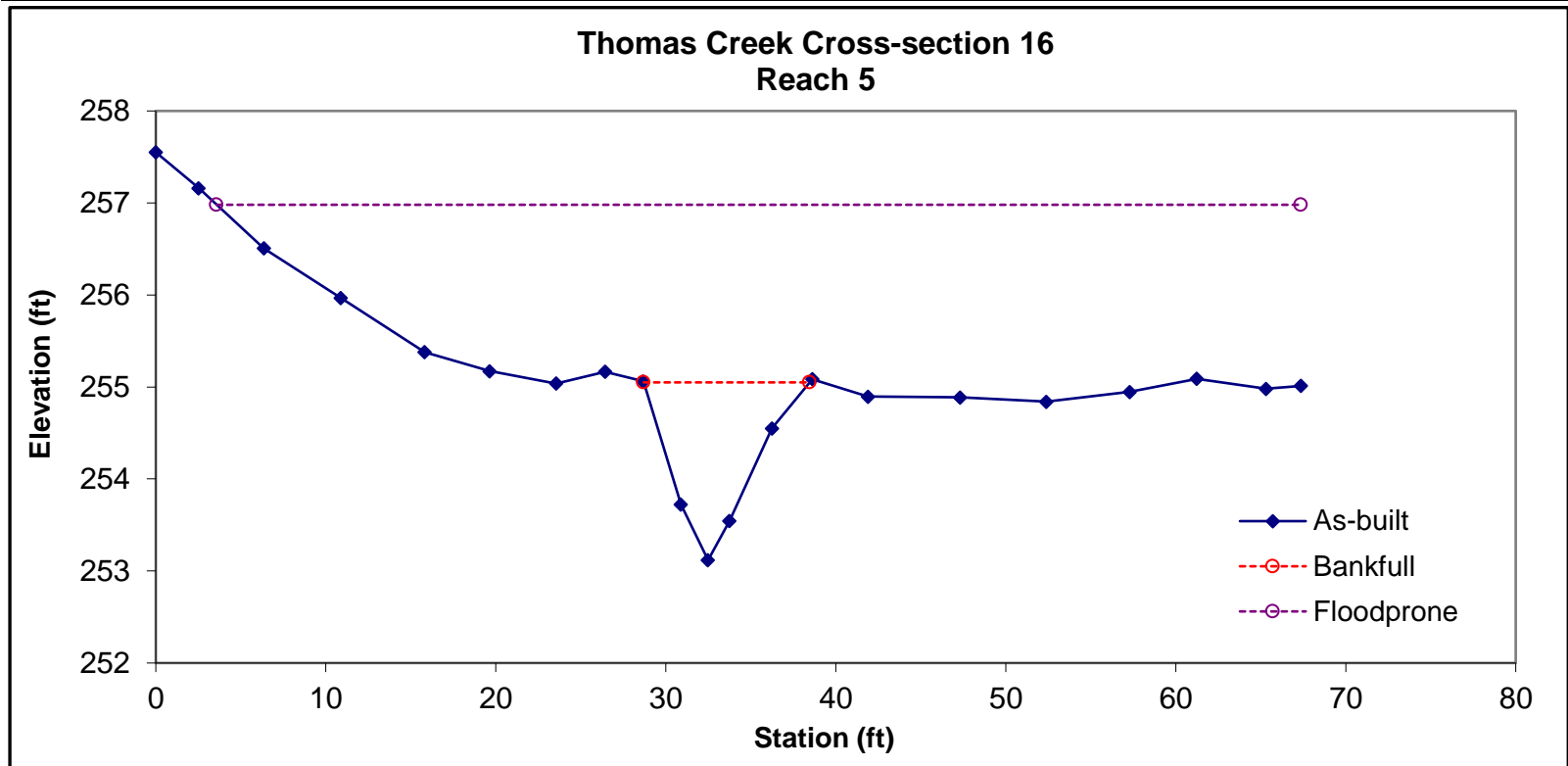


Looking at the Left Bank

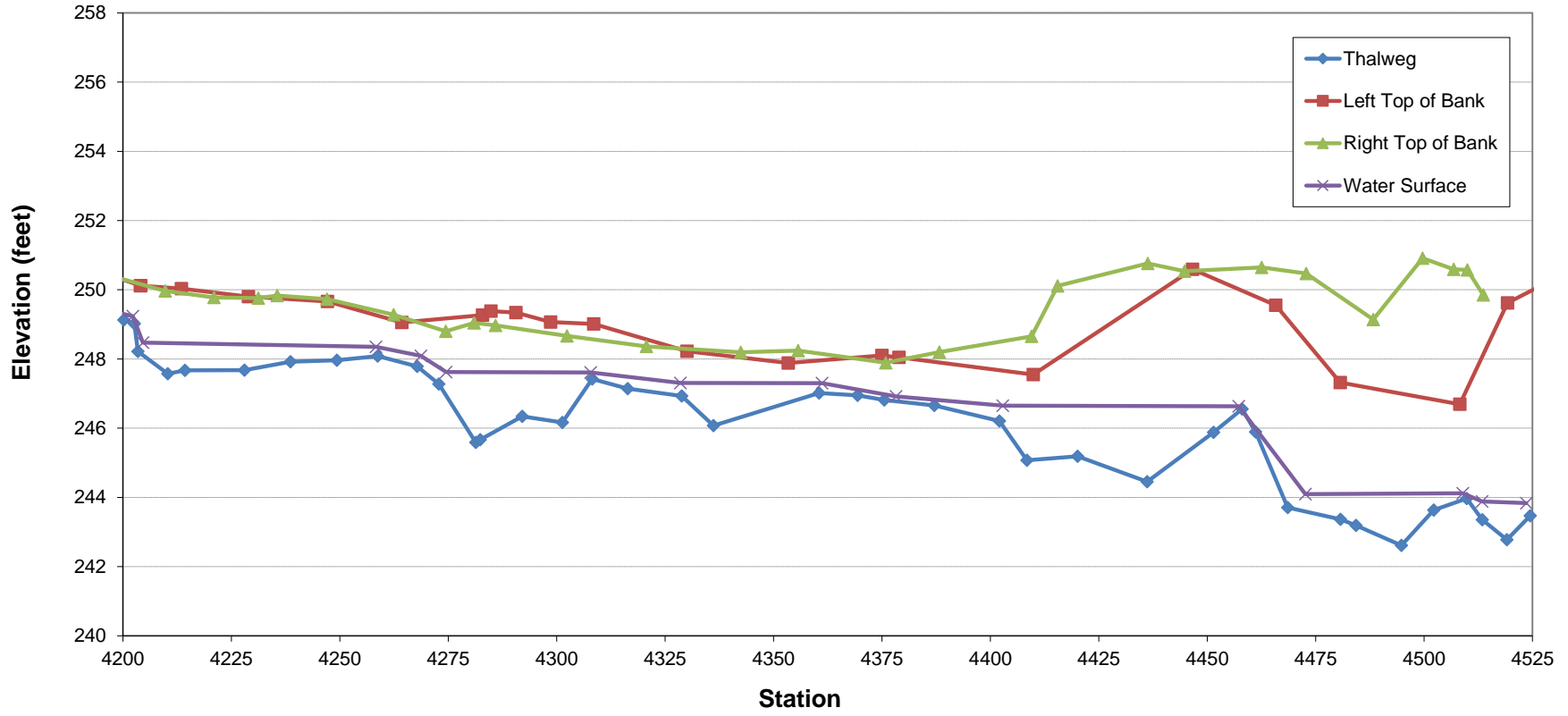


Looking at the Right Bank

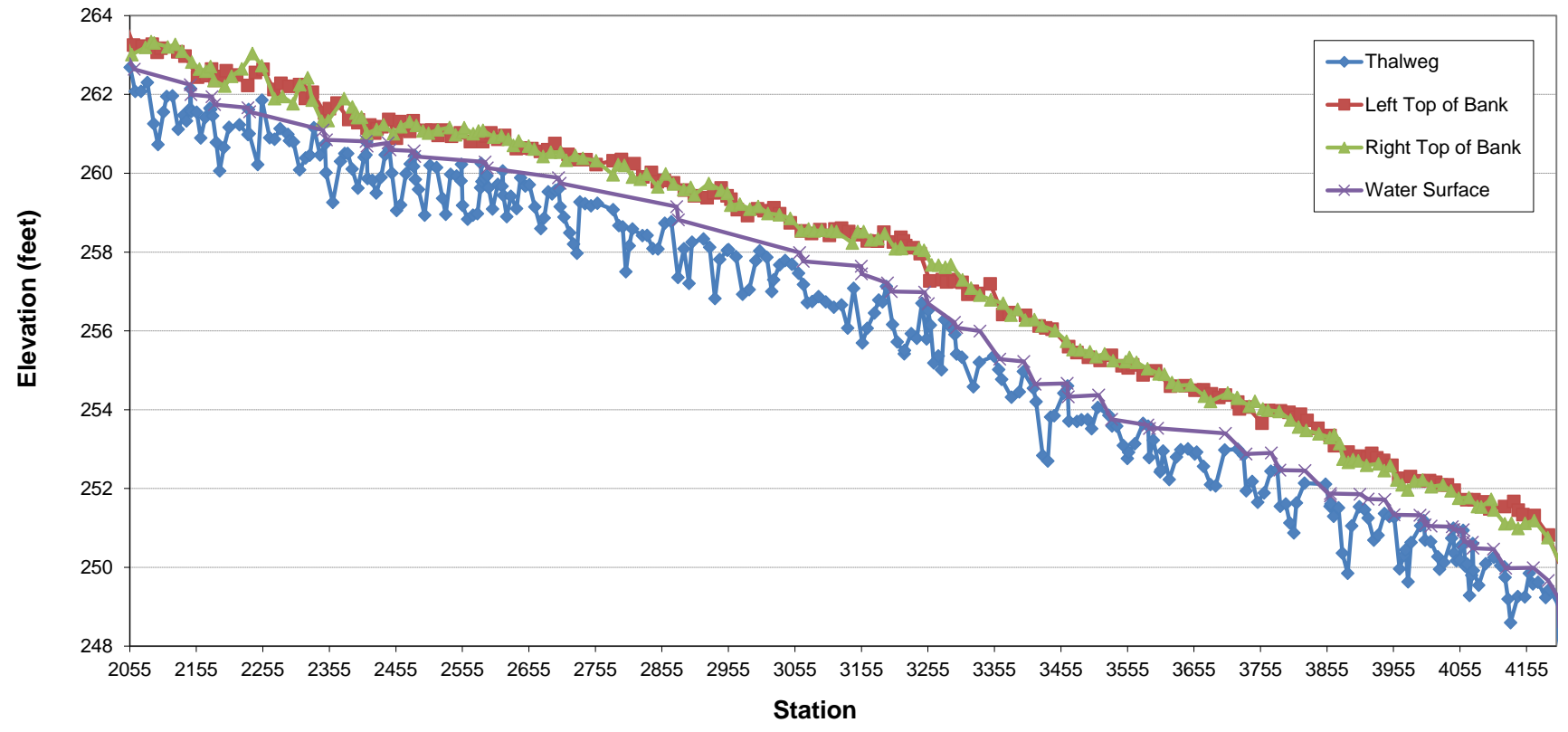
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		7.3	9.34	0.78	1.29	11.9	1	5.9	271.44	271.45



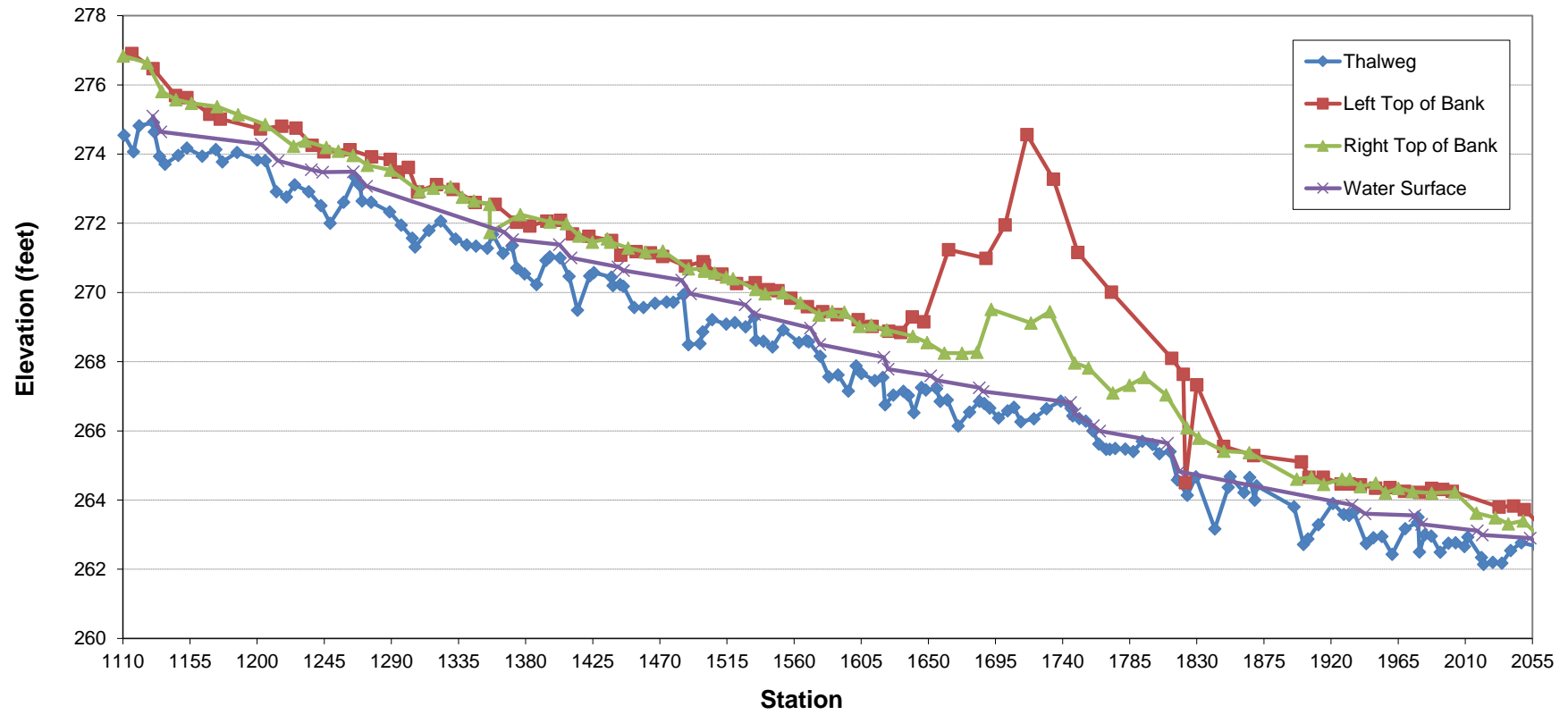
Thomas Creek - Reach 1
As-built Station 42+00 to 45+25
(Data Collected December 2015)



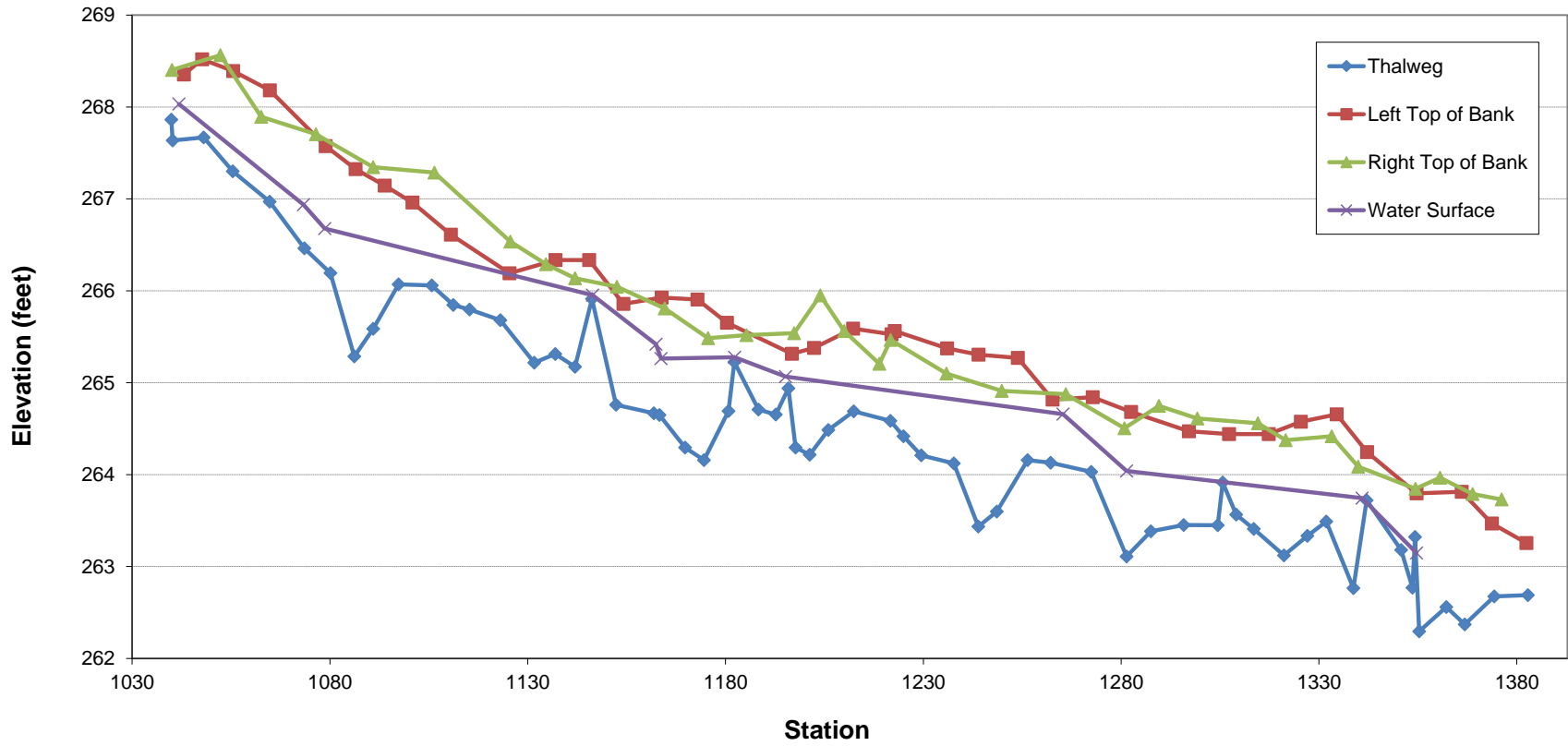
Thomas Creek - Reach 2
As-built Station 20+55 to 42+00
(Data Collected December 2015)



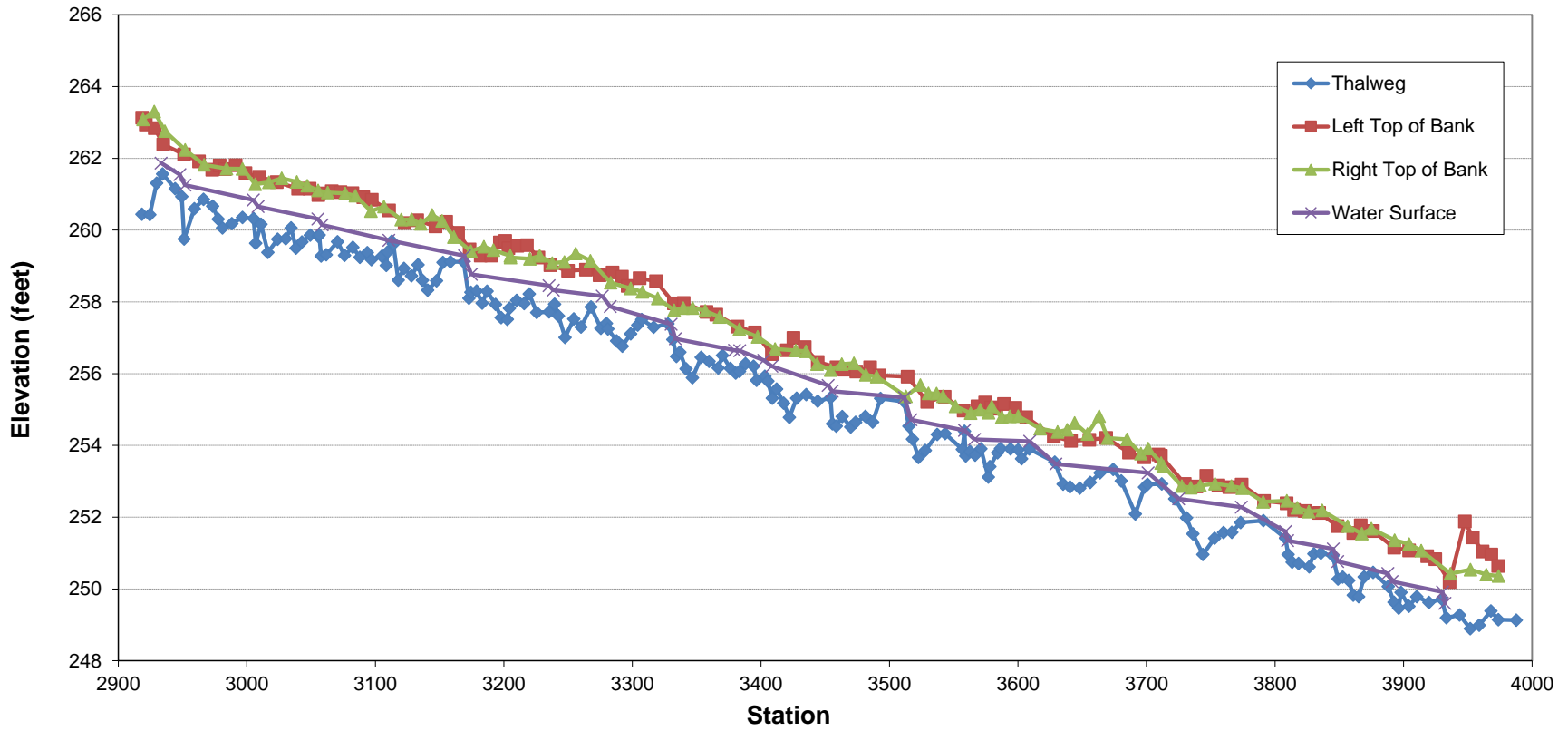
Thomas Creek - Reach 3
As-built Station 11+10 to 20+55
(Data Collected Oct/Nov 2015)



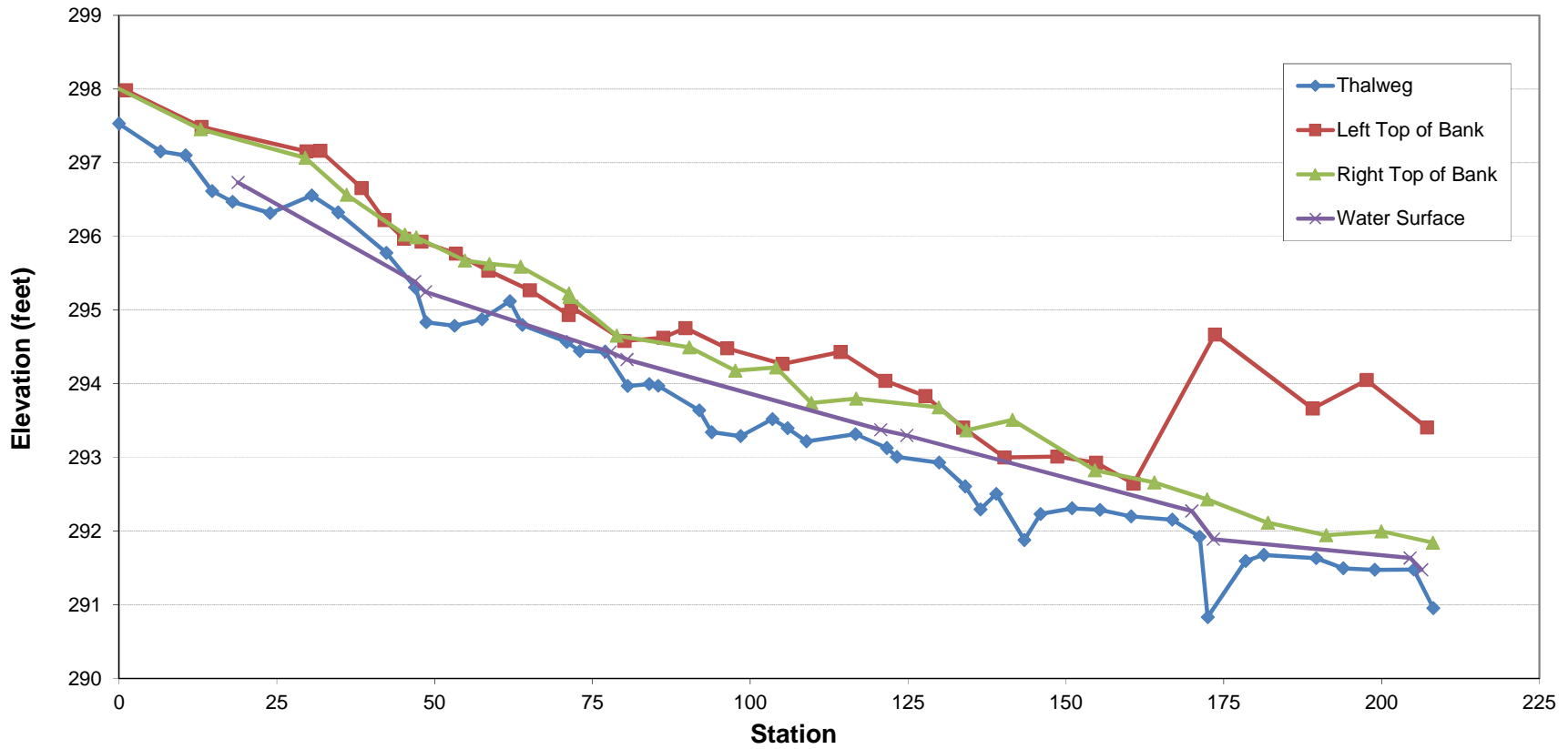
Thomas Creek - Reach 4
As-built Station 10+39 to 13+83
(Data Collected - Oct/Nov 2015)



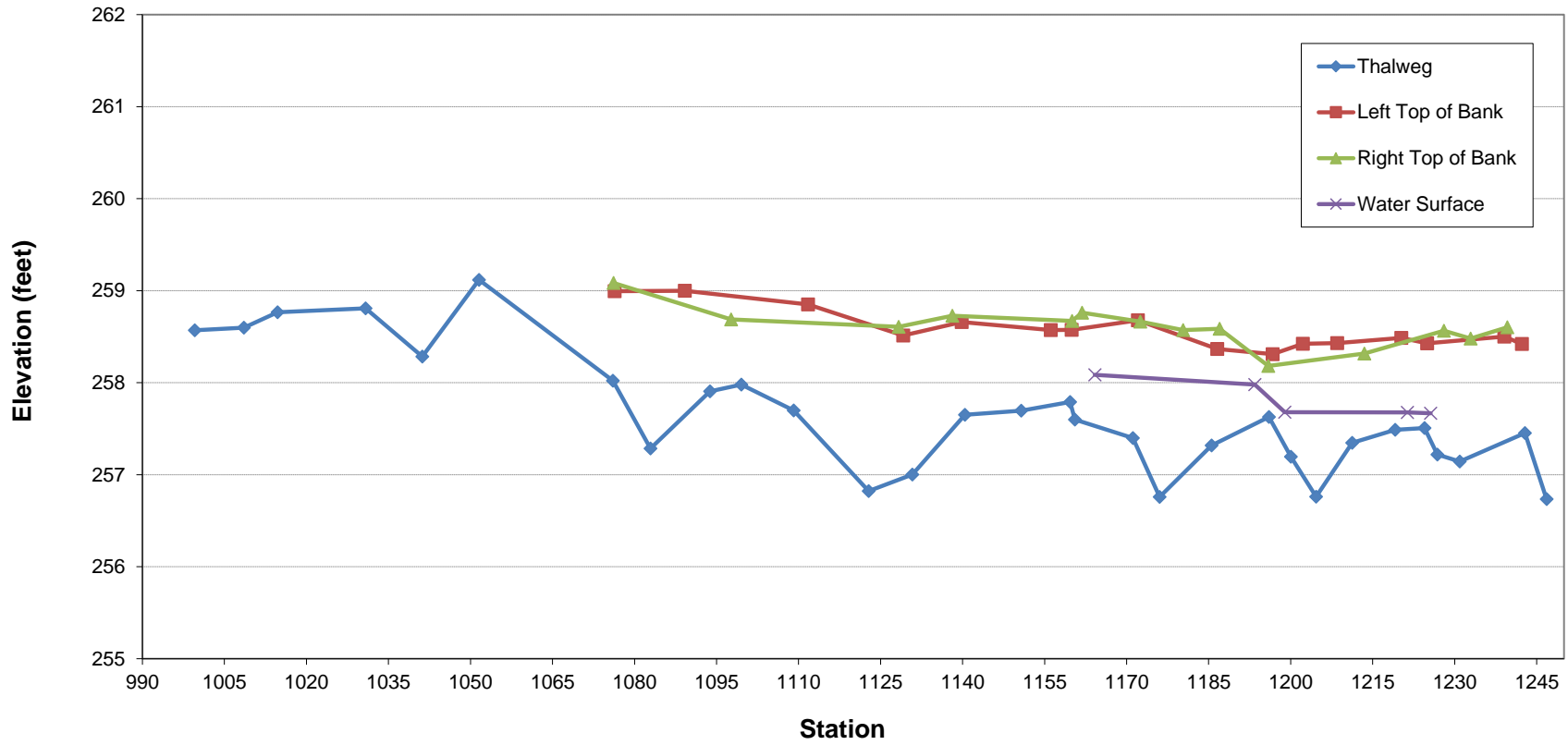
Thomas Creek - Reach 5
As-built Station 29+18 to 39+88
(Data Collected - Oct/Nov 2015)



Thomas Creek - Reach 6
As-built Station 10+00 to 12+08
(Data Collected - Oct/Nov 2015)



Thomas Creek - T1
As-built Station 10+00 to 12+47
(Data Collected - Oct/Nov 2015)



APPENDIX C

Vegetation Summary Data (Tables 7 and 8)

Table 7. Vegetation Species Planted Across the Restoration Site Thomas Creek Restoration Project: DMS Project ID No. 96074			
Botanical Name	Common Name	% Planted by Species	Total Number of Stems
Riparian Buffer Plantings			
<i>Betula nigra</i>	river birch	9.5	800
<i>Fraxinus pennsylvanica</i>	green ash	6.0	500
<i>Liriodendron tulipifera</i>	tulip poplar	9.5	800
<i>Platanus occidentalis</i>	American sycamore	11.9	1000
<i>Quercus michauxii</i>	swamp chestnut oak	9.5	800
<i>Quercus pagoda</i>	cherrybark oak	9.5	800
Riparian Buffer Plantings - Understory			
<i>Asimina triloba</i>	paw paw	9.5	800
<i>Carpinus caroliniana</i>	ironwood	14.3	1200
<i>Diospyros virginiana</i>	persimmon	6.0	500
<i>Viburnum dentatum</i>	arrowwood viburnum	14.3	1200
Riparian Live Stake Plantings			
<i>Cornus amomum</i>	silky dogwood	40%	NA
<i>Salix nigra</i>	black willow	10%	NA
<i>Salix sericea</i>	silky willow	30%	NA
<i>Sambucus canadensis</i>	elderberry	20%	NA

Table 8. Stem Count for Each Species Arranged by Plot Thomas Creek Restoration Project: DMS Project ID No. 96074																	
Botanical Name	Common Name	Thomas Creek Vegetation Plots															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tree Species																	
<i>Betula nigra</i>	river birch	5	3	2	2	3	2	6	6	2	5	2	5	4	2	6	5
<i>Fraxinus pennsylvanica</i>	green ash	2			1	1		4	1	2		3			1	1	1
<i>Liriodendron tulipifera</i>	tulip poplar	4	1		1	2	4		3			1	4	6	3	1	3
<i>Platanus occidentalis</i>	American sycamore	3	1		4	1	4	2	4	1	2	2	4	5	5	2	
<i>Quercus michauxii</i>	swamp chestnut oak	1	2	2		1	1	2	1	4	3	1	4	1	2		
<i>Quercus pagoda</i>	cherryback oak	2	1	2	1	2			1	2	2	2	1	2			2
Shrub Species																	
<i>Asimina triloba</i>	paw paw		1			1	1						1		1	1	
<i>Carpinus caroliniana</i>	ironwood		1	2	3	1		4	1		5	1	3		3	1	6
<i>Diospyros virginiana</i>	persimmon	4	1	3	3	2	2	1	1	1	3	3	1	4	2	1	1
<i>Viburnum dentatum</i>	arrowwood viburnum		6	4	1	2	1	5		4	4	9			1	4	4
Stems/plot		21	17	15	16	16	15	24	18	16	24	24	23	22	20	17	22
Stems/acre		850	688	607	648	648	607	971	728	648	971	971	931	890	809	688	890
Average Stems/ Acre for Year 0 As-Built (Baseline Data)		784															

APPENDIX D

As-Built Plan Sheets/Record Drawings

THOMAS CREEK

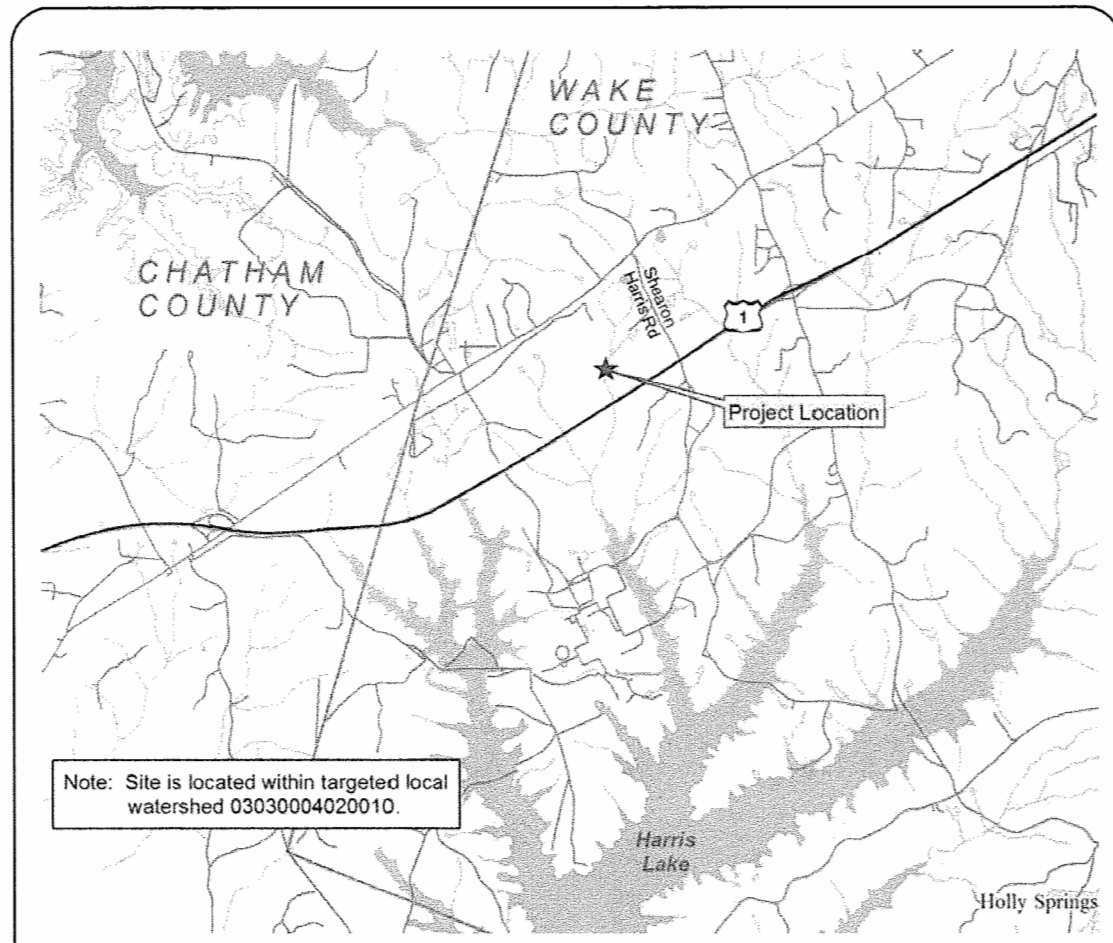
PROJECT: 135794

**NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY**

WAKE COUNTY

**LOCATION: 1.5 MILES SOUTHWEST OF THE COMMUNITY OF NEW HILL
TYPE OF WORK: AS - BUILT PLAN**

STATE	BAKER PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	135794	1	27
NCDMS ID No. 96074			

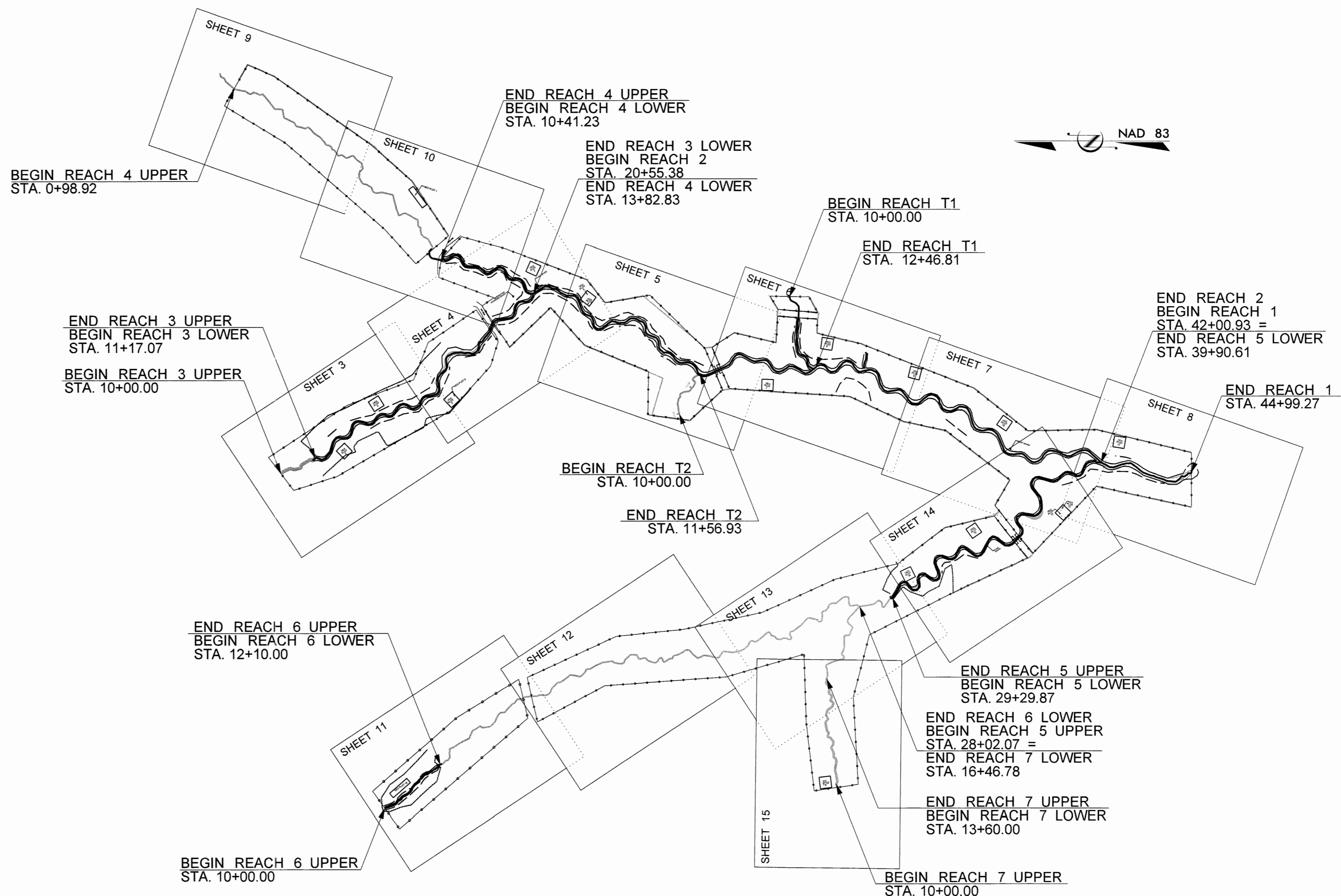


VICINITY MAP

Note: Site is located within targeted local watershed 03030004020010.

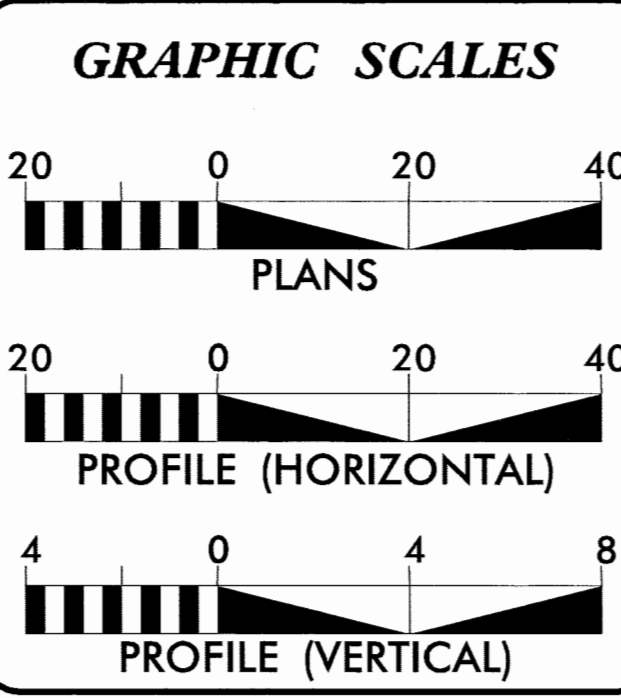
INDEX OF SHEETS

- 1 TITLE SHEET
- 1-A STREAM CONVENTIONAL SYMBOLS
GENERAL NOTES
STANDARD SPECIFICATIONS
VEGETATION SELECTION
- 1-B CONVENTIONAL SYMBOLS
- 2 - 2-E DETAILS
- 3 - 15 AS-BUILT PLAN VIEW
- 16 - 20 AS-BUILT PROFILES



I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THEREON ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 29 DAY OF September 2016

Marshall G. Wight
PROFESSIONAL LAND SURVEYOR L-5034
WithersRavenel
Engineers | Planners | Surveyors
115 MacKenzie Drive | Cary, NC 27511 | 919.489.3340 | license #: C-0882 | www.wr-engineers.com



STREAM LENGTH SUMMARY

REACH NAME	AS-BUILT STREAM LENGTH (LF)
REACH 1	298
REACH 2	2,126
REACH 3	1,031
REACH 4	1,238
REACH 5	1,169
REACH 6	1,776
REACH 7	647
REACH T1	227
REACH T2	157
TOTAL	8,669

PREPARED FOR THE OFFICE OF:

NCDEQ
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652

CONTACT: JEFF SCHAFFER
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

Michael Baker International
Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.463.5468
Fax: 919.463.5490
License #: F-1084

LETTING DATE: _____

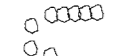





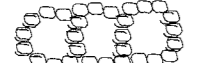
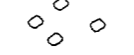

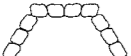
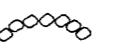


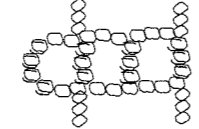





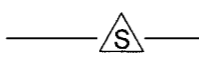

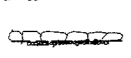



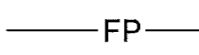

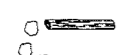
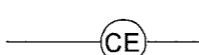
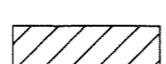

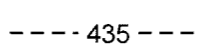
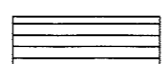

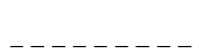





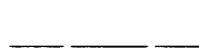


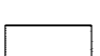
JACOB M. BYERS, PE
PROJECT ENGINEER

SCOTT KING, LSS. PWS
PROJECT MANAGER

PROJECT ENGINEER

Jacob M. Byers 9/29/16 P.E.
SIGNATURE



STREAM CONVENTIONAL SYMBOLS
SUPERCEDES SHEET 1-B

 ROCK J-HOOK	 LOG STEP-POOL	 FOOT BRIDGE
 ROCK VANE / SILL	 CONSTRUCTED RIFFLE	 TEMPORARY STREAM CROSSING
 OUTLET PROTECTION	 BOULDER CLUSTER	 PERMANENT FORD STREAM CROSSING
 ROCK CROSS VANE	 BOULDER REVETMENT	 SLOPE DRAIN
 DOUBLE DROP ROCK CROSS VANE	 ROCK STEP POOL	 TRANSPLANTED VEGETATION
 SINGLE WING DEFLECTOR	 VERNAL POOL	 TREE REMOVAL
 DOUBLE WING DEFLECTOR	 SAFETY FENCE	 TREE PROTECTION
 TEMPORARY SILT CHECK	 TAPE FENCE	 DITCH PLUG/CHANNEL BLOCK
 ROOT WAD	 100 YEAR FLOOD PLAIN	 CHANNEL FILL
 LOG J-HOOK	 CONSERVATION EASEMENT	 BRUSH MATTRESS
 GRADE CONTROL LOG J-HOOK	 EXISTING MAJOR CONTOUR	 GEOLIFT WITH BRUSH TOE
 LOG VANE	 EXISTING MINOR CONTOUR	 CREST GAUGE
 LOG WEIR	 LIMITS OF DISTURBANCE	 FLOW GAUGE
 GRADE CONTROL LOG JAM	 PROPERTY LINE	 BAROMETRIC PRESSURE GAUGE
 LOG CROSS VANE		 VEG PLOT

**NOTE: ALL ITEMS ABOVE MAY NOT BE USED ON THIS PROJECT

GENERAL NOTES

1. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES USING A TRACK HOE WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE BOULDERS (3'x2'x2'), LOGS AND ROOTWADS.
2. WORK IS BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN. THE CONTRACTOR SHOULD MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK.
3. CONSTRUCTION IS SCHEDULED TO BEGIN SPRING OF 2015.
4. CONTRACTOR SHOULD CALL NORTH CAROLINA "ONE-CALL" BEFORE EXCAVATION STARTS. (1-800-632-4949)
5. ENGINEER WILL FLAG TREES TO BE SAVED PRIOR TO CONSTRUCTION.

PROJECT REFERENCE NO. 135794	SHEET NO. 1-A
PROJECT ENGINEER	
	
APPROVED BY: 	
DATE: 7/29/16	
Michael Baker International <small>Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 500 Cary, NORTH CAROLINA 27518 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1084</small>	
NCDMS ID No. 96074	

STANDARD SPECIFICATIONS

NORTH CAROLINA
EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL
MARCH 2009 (REV 2013)

- 6.05 TREE PROTECTION
- 6.06 TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- 6.24 RIPARIAN AREA SEEDING
- 6.60 TEMPORARY SEDIMENT TRAP
- 6.62 TEMPORARY SILT FENCE
- 6.63 TEMPORARY ROCK DAM
- 6.70 TEMPORARY STREAM CROSSING

VEGETATION SELECTION

Proposed Bare-Root and Live Stake Species			
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074			
Botanical Name	Common Name	% Planted by Species	Wetland Tolerance
Riparian Buffer Plantings - 8' x 8' spacing - 680 stems/Acre			
Overstory Species			
<i>Fraxinus pennsylvanica</i>	Green Ash	6.0%	FACW
<i>Betula nigra</i>	River Birch	9.5%	FACW
<i>Liriodendron tulipifera</i>	Tulip Poplar	9.5%	FAC
<i>Quercus pagoda</i>	Cherrybark Oak	9.5%	FACW
<i>Quercus michauxii</i>	Swamp Chestnut Oak	9.5%	FACW-
<i>Diospyros virginiana</i>	Persimmon	6.0%	FAC
<i>Platanus occidentalis</i>	American Sycamore	12.0%	FACW-
Understory Species			
<i>Carpinus caroliniana</i>	American Hornbeam	14.3%	FAC
<i>Viburnum dentatum</i>	Arrowwood Viburnum	14.3%	FAC
<i>Asimina triloba</i>	Paw Paw	9.5%	FAC
Riparian Live Stake Plantings			
<i>Salix nigra</i>	Black Willow	10%	OBL
<i>Sambucus canadensis</i>	Elderberry	20%	FACW-
<i>Salix sericea</i>	Silky Willow	30%	OBL
<i>Cornus amomum</i>	Silky Dogwood	40%	FACW+

Proposed Permanent Seed Mixture				
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074				
Botanical Name	Common Name	% Planted by Species	Density (lbs/ac)	Wetland Tolerance
<i>Andropogon gerardii</i>	Big blue stem	10%	1.5	FAC
<i>Dichanthelium clandestinum</i>	Deer tongue	15%	1.5	FACW
<i>Carex crinata</i>	Fringed sedge	10%	2.25	FACW+
<i>Elymus virginicus</i>	Virginia wild rye	15%	1.5	FAC
<i>Juncus effusus</i>	Soft rush	10%	2.25	FACW+
<i>Panicum virgatum</i>	Switchgrass	15%	1.5	FAC+
<i>Schizachyrium scoparium</i>	Little blue stem	15%	0.75	FACU
<i>Sorghastrum nutans</i>	Indiangrass	10%	0.75	FACU
	Total	100%	15	

Temporary Seed Mixture		
The following table lists temporary seed mix for the project site. All disturbed areas were stabilized using mulch and temporary seed as defined in the construction specifications.		
Planting Dates	Species Name	Rate (lbs./acre)
September to March	Rye Grain (Cool Season)	130
April to August	Browntop Millet (Warm Season)	40

2/26/2016

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STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

CONVENTIONAL SYMBOLS

BOUNDARIES AND PROPERTY:

State Line	-----
County Line	-----
Township Line	-----
City Line	-----
Reservation Line	-----
Property Line	-----
Existing Iron Pin	○ EP
Property Corner	-----
Property Monument	□ ECM
Parcel/Sequence Number	(23)
Existing Fence Line	-x-x-x-
Proposed Woven Wire Fence	○
Proposed Chain Link Fence	□
Proposed Barbed Wire Fence	◇
Existing Wetland Boundary	-WLB-
Proposed Wetland Boundary	-WLB-
Existing Endangered Animal Boundary	-EAB-
Existing Endangered Plant Boundary	-EPB-

BUILDINGS AND OTHER CULTURE:

Gas Pump Vent or U/G Tank Cap	○
Sign	○ S
Well	○ W
Small Mine	⋈
Foundation	□
Area Outline	□
Cemetery	□
Building	□
School	□
Church	□
Dam	□

HYDROLOGY:

Stream or Body of Water	-----
Hydro, Pool or Reservoir	□
Jurisdictional Stream	-JS-
Buffer Zone 1	-BZ 1-
Buffer Zone 2	-BZ 2-
Flow Arrow	←
Disappearing Stream	→
Spring	○
Wetland	⬇
Proposed Lateral, Tail, Head Ditch	← FLOW
False Sump	◇

RAILROADS:

Standard Gauge	-----
RR Signal Milepost	○ MILEPOST 35
Switch	□ SWITCH
RR Abandoned	-----
RR Dismantled	-----

RIGHT OF WAY:

Baseline Control Point	◆
Existing Right of Way Marker	△
Existing Right of Way Line	-----
Proposed Right of Way Line	-----
Proposed Right of Way Line with Iron Pin and Cap Marker	○
Proposed Right of Way Line with Concrete or Granite Marker	○
Existing Control of Access	⊗
Proposed Control of Access	⊗
Existing Easement Line	-E-
Proposed Temporary Construction Easement	-E-
Proposed Temporary Drainage Easement	-TDE-
Proposed Permanent Drainage Easement	-PDE-
Proposed Permanent Utility Easement	-PUE-
Proposed Temporary Utility Easement	-TUE-
Proposed Permanent Easement with Iron Pin and Cap Marker	◆

ROADS AND RELATED FEATURES:

Existing Edge of Pavement	-----
Existing Curb	-----
Proposed Slope Stakes Cut	-C-
Proposed Slope Stakes Fill	-F-
Proposed Wheel Chair Ramp	WCR
Existing Metal Guardrail	-----
Proposed Guardrail	-----
Existing Cable Guiderail	-----
Proposed Cable Guiderail	-----
Equality Symbol	⊗
Pavement Removal	⊗

VEGETATION:

Single Tree	⊗
Single Shrub	⊗
Hedge	-----
Woods Line	-----
Orchard	⊗
Vineyard	□ Vineyard

*S.U.E = SUBSURFACE UTILITY ENGINEER

EXISTING STRUCTURES:

MAJOR:	
Bridge, Tunnel or Box Culvert	CONC
Bridge Wing Wall, Head Wall and End Wall	CONC WW
MINOR:	
Head and End Wall	CONC HW
Pipe Culvert	-----
Footbridge	-----
Drainage Box: Catch Basin, DI or JB	□ CB
Paved Ditch Gutter	-----
Storm Sewer Manhole	⊗
Storm Sewer	-S-

UTILITIES:

POWER:	
Existing Power Pole	●
Proposed Power Pole	○
Existing Joint Use Pole	●
Proposed Joint Use Pole	○
Power Manhole	⊗
Power Line Tower	⊗
Power Transformer	⊗
U/G Power Cable Hand Hole	□
H-Frame Pole	●
Recorded U/G Power Line	-P-
Designated U/G Power Line (S.U.E.*)	-P-

TELEPHONE:

Existing Telephone Pole	●
Proposed Telephone Pole	○
Telephone Manhole	⊗
Telephone Booth	□
Telephone Pedestal	□
Telephone Cell Tower	⊗
U/G Telephone Cable Hand Hole	□
Recorded U/G Telephone Cable	-T-
Designated U/G Telephone Cable (S.U.E.*)	-T-
Recorded U/G Telephone Conduit	-TC-
Designated U/G Telephone Conduit (S.U.E.*)	-TC-
Recorded U/G Fiber Optics Cable	-T FO-
Designated U/G Fiber Optics Cable (S.U.E.*)	-T FO-

WATER:

Water Manhole	⊗
Water Meter	○
Water Valve	⊗
Water Hydrant	⊗
Recorded U/G Water Line	-W-
Designated U/G Water Line (S.U.E.*)	-W-
Above Ground Water Line	-A/G Water-

TV:

TV Satellite Dish	⊗
TV Pedestal	□
TV Tower	⊗
U/G TV Cable Hand Hole	□
Recorded U/G TV Cable	-TV-
Designated U/G TV Cable (S.U.E.*)	-TV-
Recorded U/G Fiber Optic Cable	-TV FO-
Designated U/G Fiber Optic Cable (S.U.E.*)	-TV FO-

GAS:

Gas Valve	◇
Gas Meter	⊗
Recorded U/G Gas Line	-G-
Designated U/G Gas Line (S.U.E.*)	-G-
Above Ground Gas Line	-A/G Gas-

SANITARY SEWER:

Sanitary Sewer Manhole	⊗
Sanitary Sewer Cleanout	⊗
U/G Sanitary Sewer Line	-SS-
Above Ground Sanitary Sewer	-A/G Sanitary Sewer-
Recorded SS Forced Main Line	-FSS-
Designated SS Forced Main Line (S.U.E.*)	-FSS-

MISCELLANEOUS:

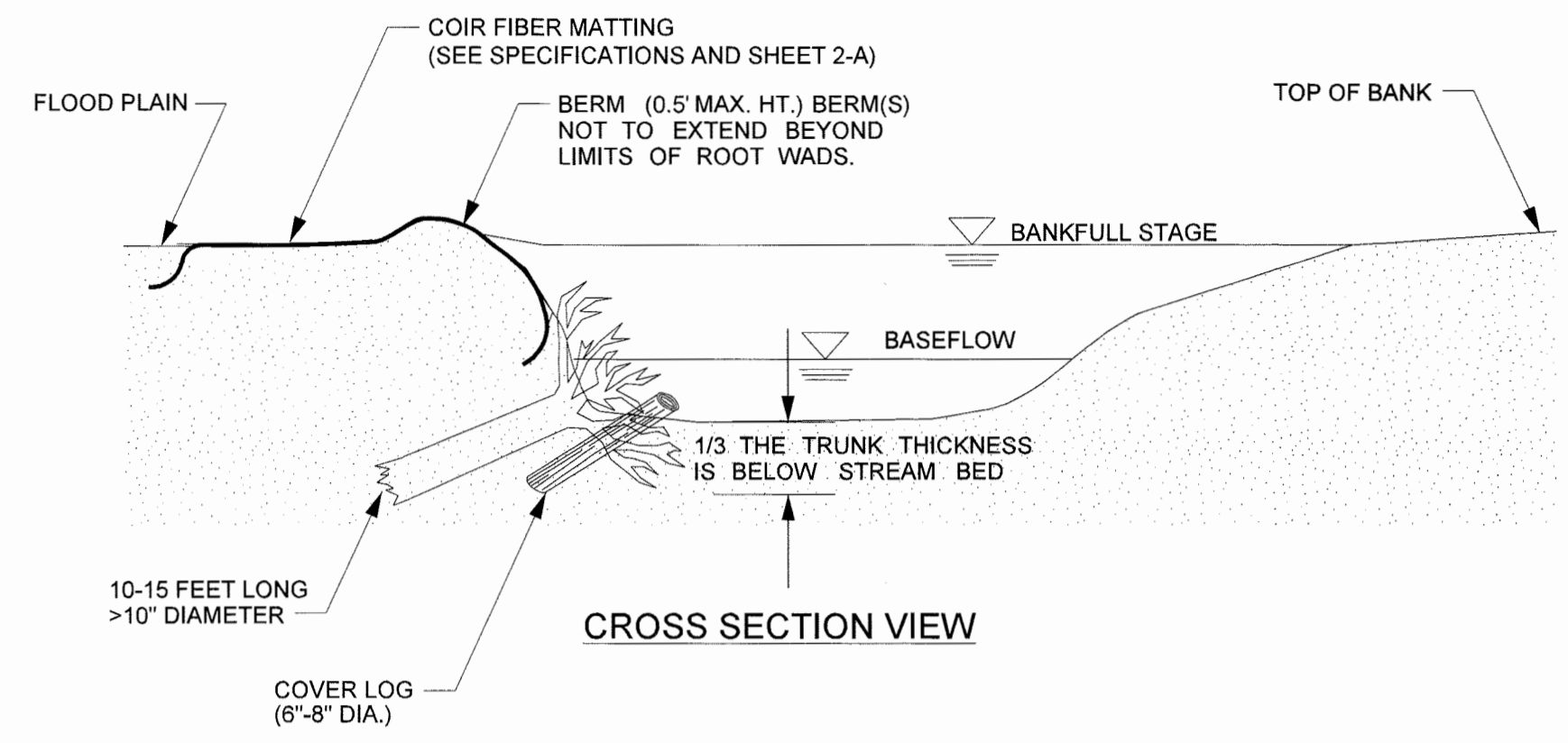
Utility Pole	●
Utility Pole with Base	□
Utility Located Object	○
Utility Traffic Signal Box	□
Utility Unknown U/G Line	-?U/L-
U/G Tank; Water, Gas, Oil	□
A/G Tank; Water, Gas, Oil	□
U/G Test Hole (S.U.E.*)	⊗
Abandoned According to Utility Records	AATUR
End of Information	E.O.I.

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9/13/2016
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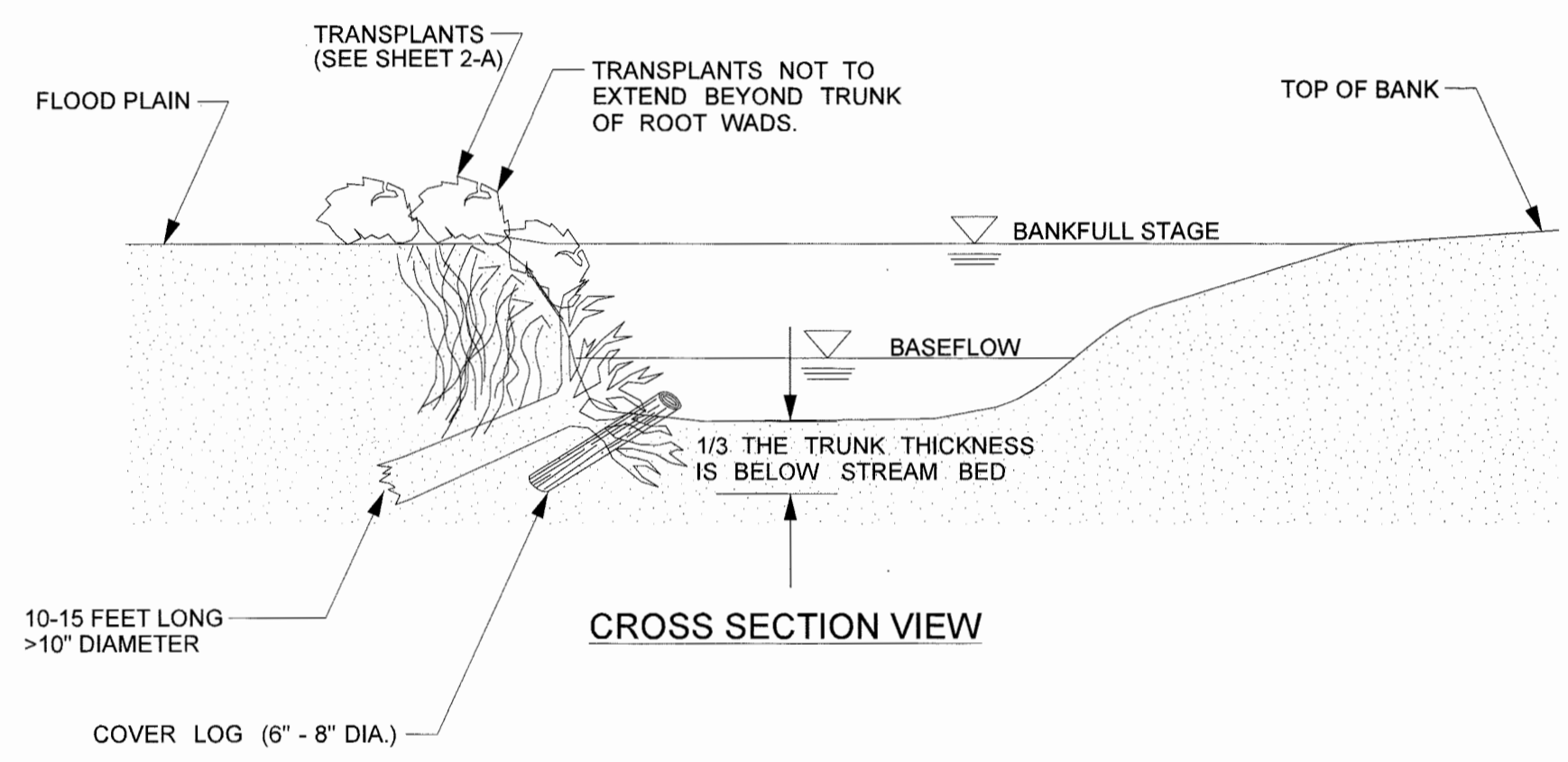
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ROOT WADS

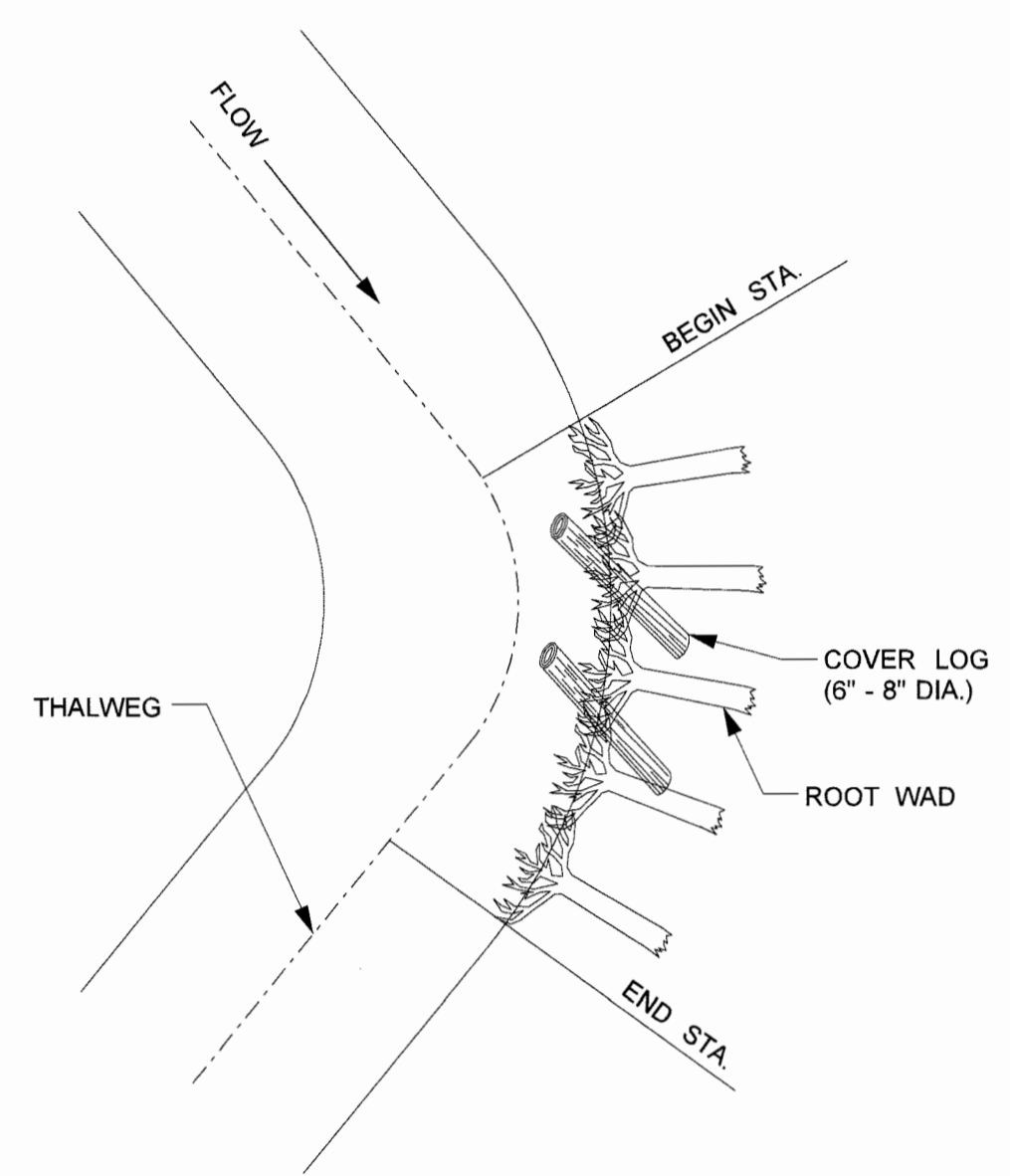
ROOT WADS WITHOUT TRANSPLANTS
USE IF TRANSPLANTS ARE NOT AVAILABLE ON-SITE



ROOT WADS WITH TRANSPLANTS
USE IF TRANSPLANTS ARE AVAILABLE ON-SITE



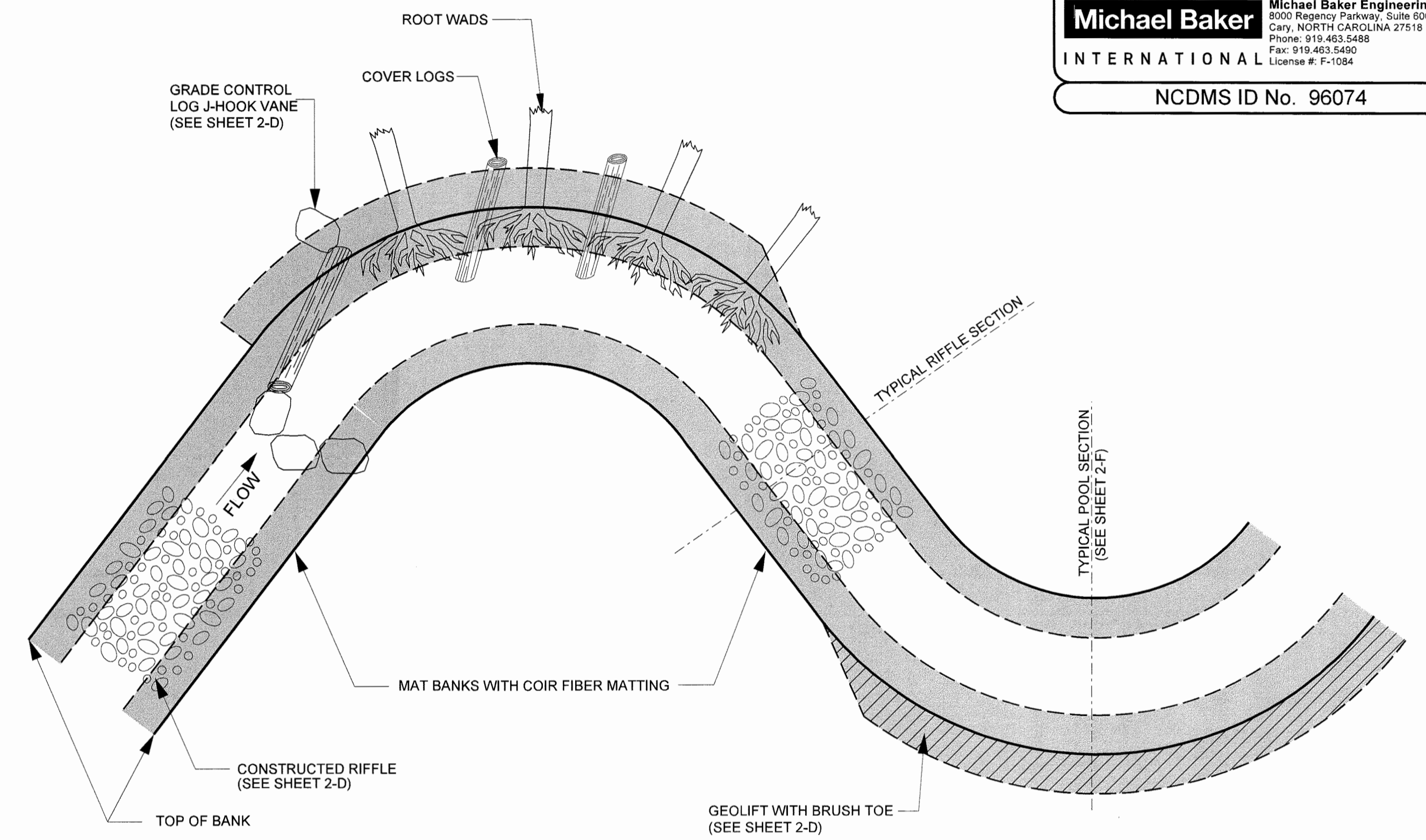
PLAN VIEW



- NOTES:**
1. INSTALLATION USING THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOT WAD. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS OR CHANNEL BOTTOM.
 2. THE NUMBER OF ROOTWADS ESTIMATED MAY VARY DEPENDING ON THE ROOTMASS SIZE. IN GENERAL, ROOTWADS SHOULD PROTECT THE OUTER MEANDER BEND AS SHOWN. SEE STRUCTURE TABLE FOR APPROXIMATE STATION AND LOCATION.
 3. INSTALL COVER LOGS BETWEEN ROOTWADS TO PROVIDE HABITAT ONLY WHEN AVAILABLE FROM ON-SITE HARVESTING.

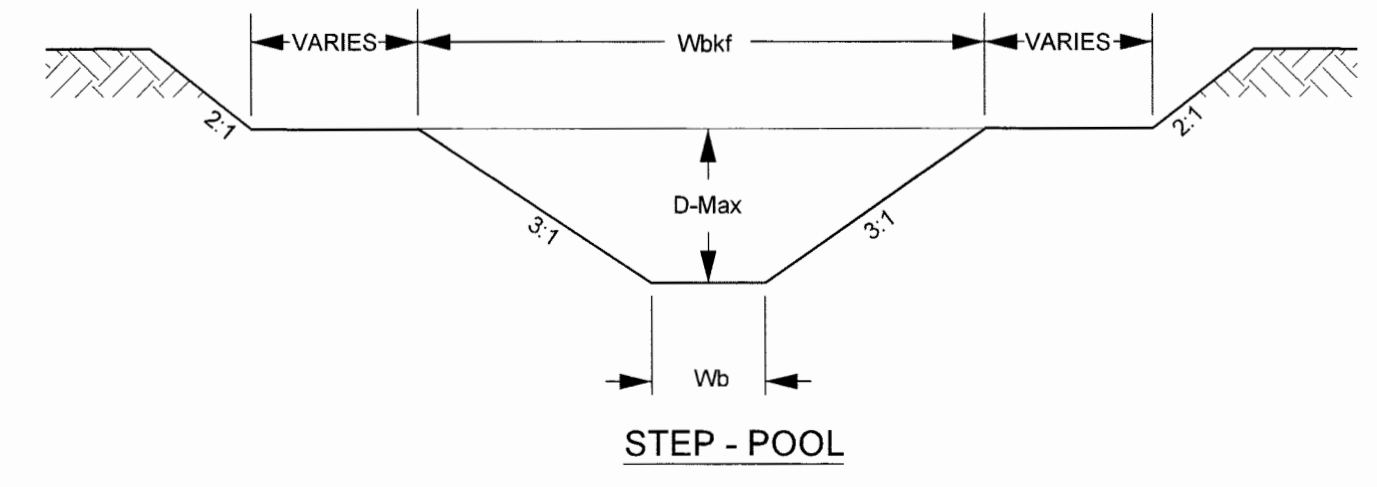
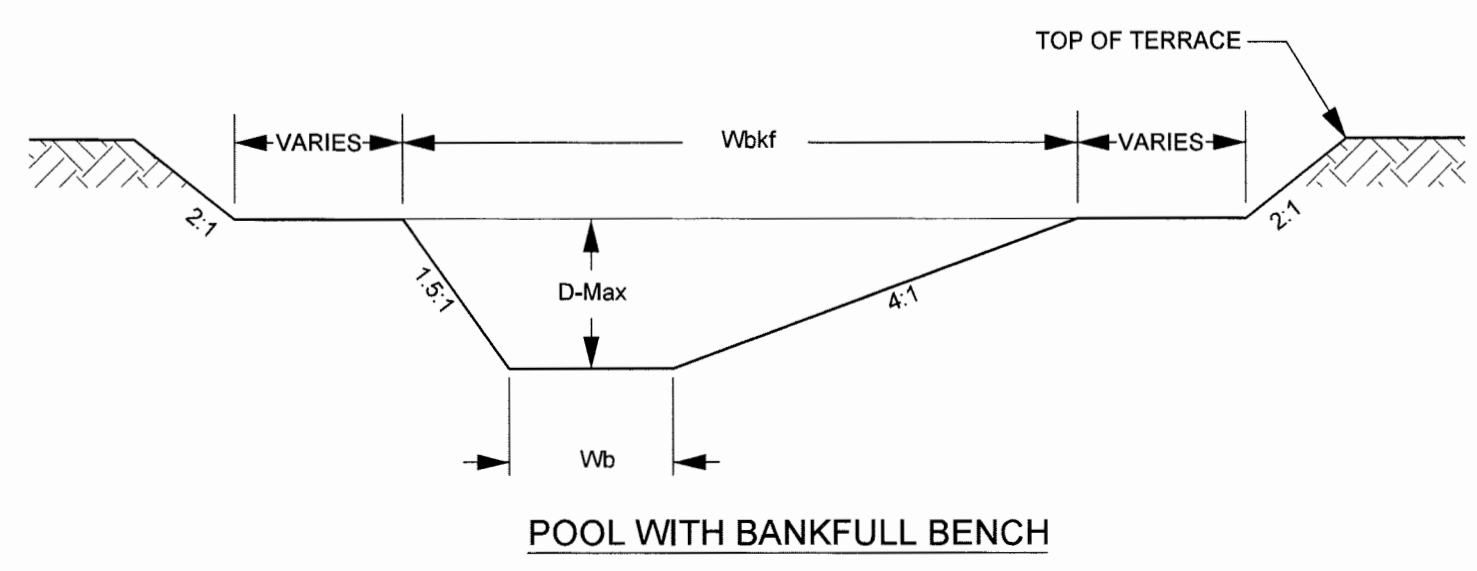
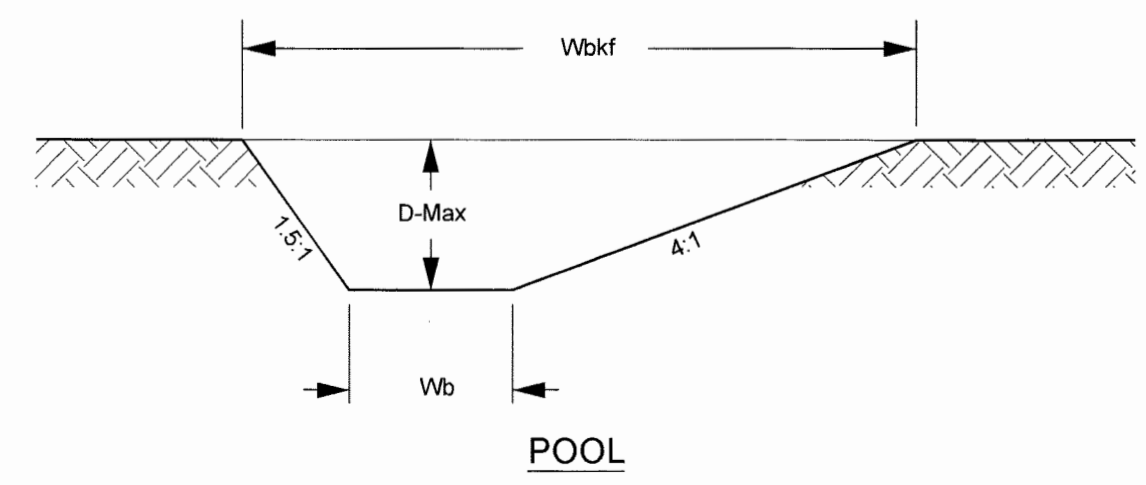
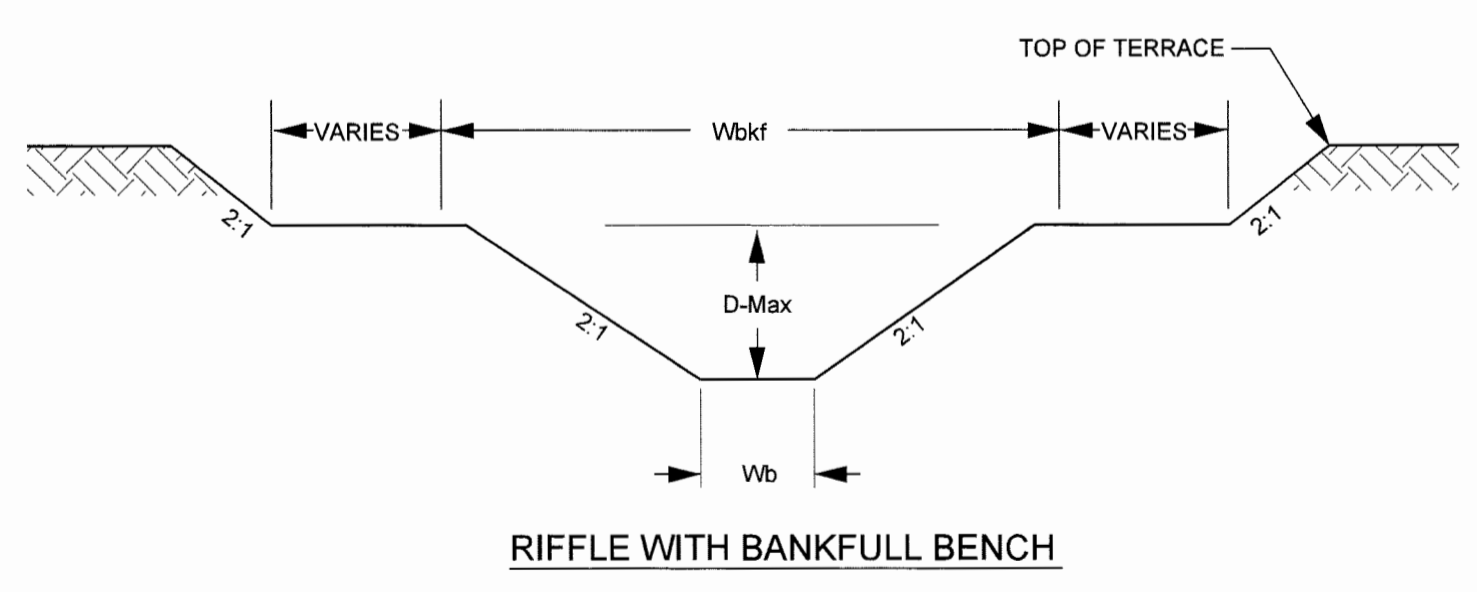
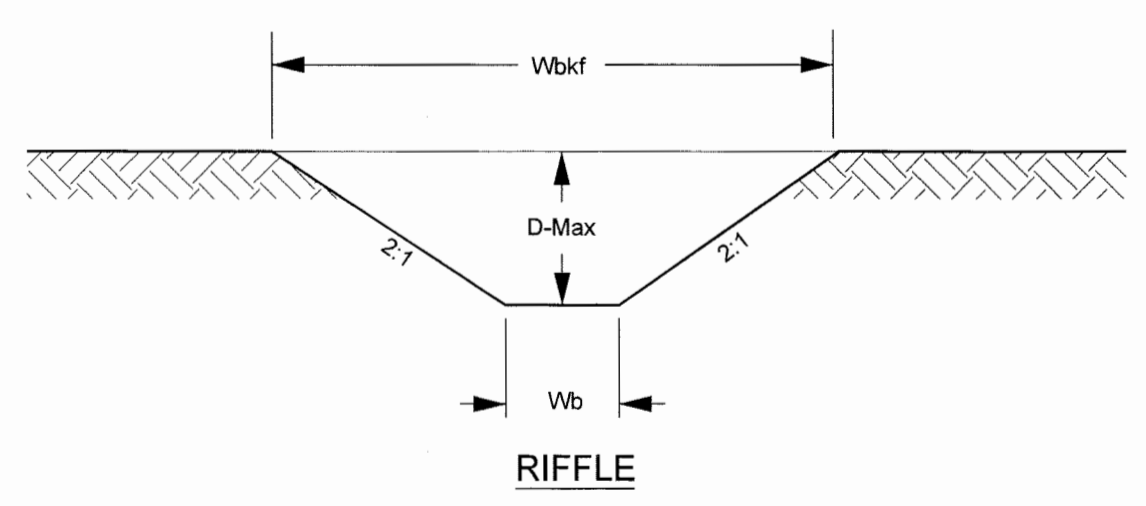
TYPICAL STRUCTURE PLACEMENT

- STRUCTURE NOTES:**
1. GENERALLY CONSTRUCTED RIFFLES, ROOT WADS, LOG VANES AND COIR FIBER MATTING WILL BE INSTALLED IN THE LOCATION AND SEQUENCE AS SHOWN.
 2. ANY CHANGES TO NUMBER OR LOCATION OF STRUCTURES DURING CONSTRUCTION MUST BE APPROVED BY THE DESIGN ENGINEER.
 3. COIR FIBER MATTING TO BE INSTALLED ON ALL RESTORED STREAMBANKS, FLOODPLAIN BENCHING, AND TERRACE SLOPES AS DESCRIBED IN THE TECHNICAL SPECIFICATIONS.



BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 2
PROJECT ENGINEER <i>[Signature]</i>	
APPROVED BY: <i>[Signature]</i>	
DATE: 9/29/16	
Michael Baker International Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.483.5488 Fax: 919.483.5490 License #: F-1094	
NCDMS ID No. 96074	

TYPICAL RIFFLE, POOL, AND BANKFULL BENCH CROSS-SECTIONS



R1		R2-Top		R2-Bottom *	
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL
12.5	17.5	9.2	12.0	10.4	13.7
1.1	2.4	0.8	1.7	1.0	1.9
14.0	12.4	14.0	11.6	14.0	11.7
11.2	24.7	6.0	12.5	7.7	16.1
8.2	3.1	6.0	2.7	5.5	3.3

WIDTH OF BANKFULL (Wbkf)
MAXIMUM DEPTH (D-Max)
WIDTH TO DEPTH RATIO (Wbkf / D)
BANKFULL AREA (Abkf)
BOTTOM WIDTH (Wb)

R3		R4		R5 *	
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL
7.0	10.0	6.3	8.5	6.8	9.0
0.7	1.5	0.6	1.1	0.7	1.3
12.0	11.3	13.0	12.0	13.0	11.5
4.1	8.8	3.1	6.0	3.6	7.1
4.0	1.8	3.9	2.5	3.3	1.9

WIDTH OF BANKFULL (Wbkf)
MAXIMUM DEPTH (D-Max)
WIDTH TO DEPTH RATIO (Wbkf / D)
BANKFULL AREA (Abkf)
BOTTOM WIDTH (Wb)

R6 / R7 *		T1		T2	
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL
4.6	6.7	7.0	9.0	3.5	6.0
0.4	1.0	0.7	1.4	0.4	0.8
14.0	11.4	13.0	10.5	12.0	11.8
1.5	4.0	3.8	7.7	1.0	3.0
2.4	1.2	4.4	2.0	2.0	1.6

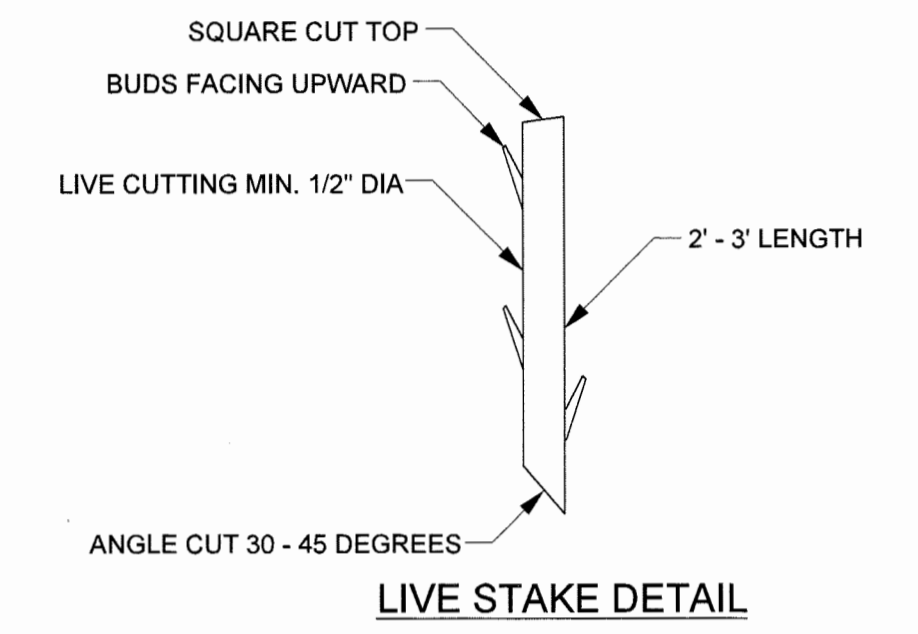
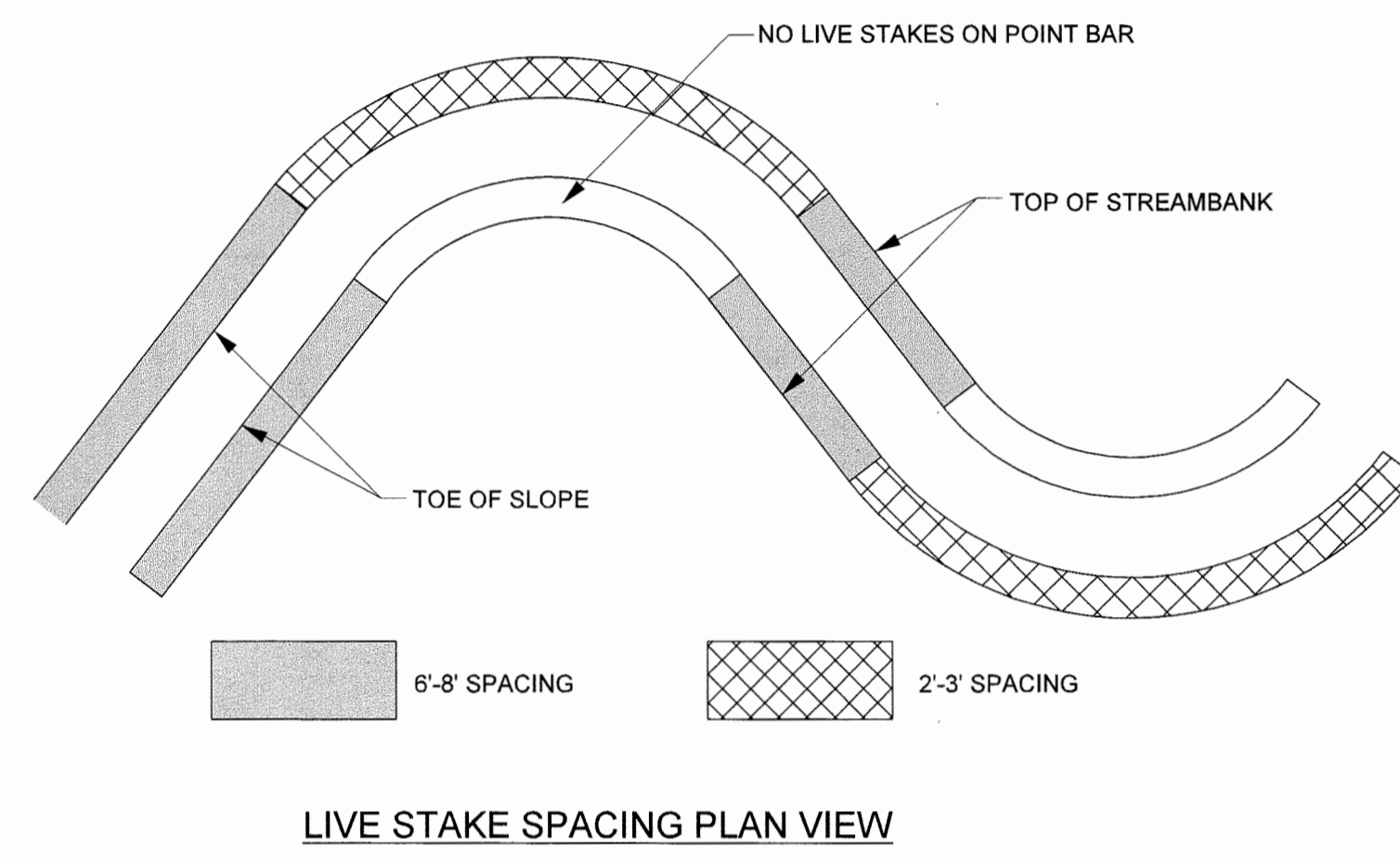
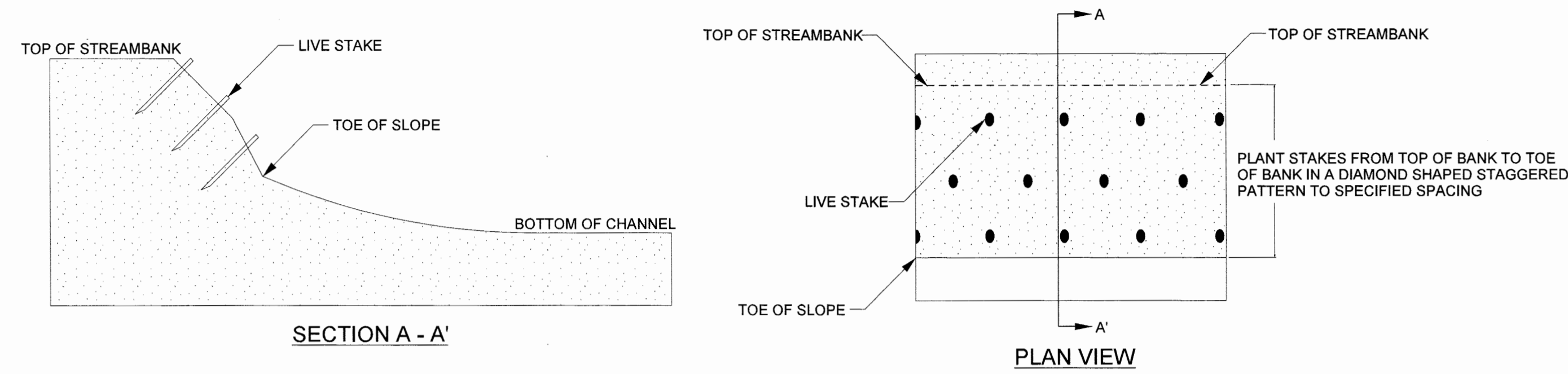
WIDTH OF BANKFULL (Wbkf)
MAXIMUM DEPTH (D-Max)
WIDTH TO DEPTH RATIO (Wbkf / D)
BANKFULL AREA (Abkf)
BOTTOM WIDTH (Wb)

* USE 2.5:1 RIFFLE SIDE SLOPE

- NOTES:**
1. DURING CONSTRUCTION CORNERS OF DESIGN CHANNEL WILL BE ROUNDED AND A THALWEG WILL BE SHAPED PER DIRECTION OF ENGINEER.
 2. POOLS SHOWN ABOVE ARE LEFT POOLS FOR MEANDER CHANNELS.

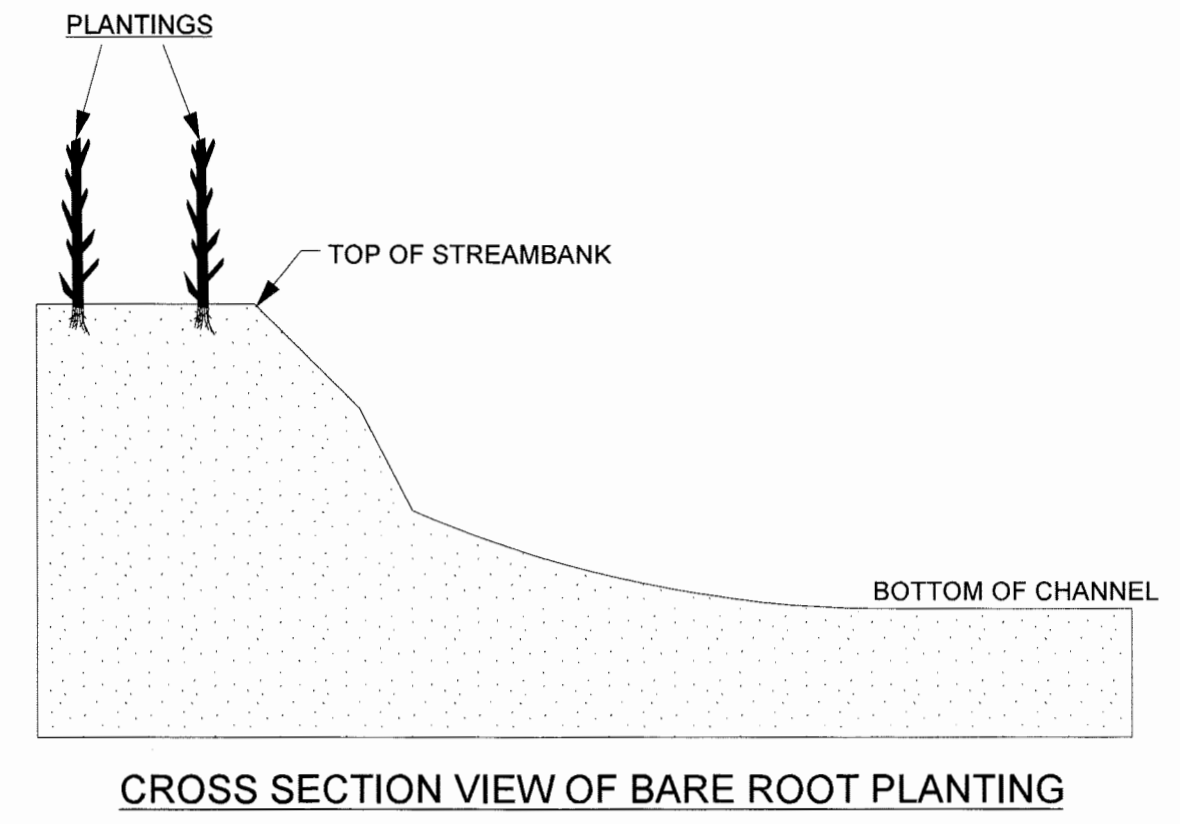
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LIVE STAKING



- NOTES:**
1. STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
 2. DO NOT INSTALL STAKES THAT HAVE BEEN SPLIT.
 3. STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
 4. STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
 5. STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3 FT LONG.
 6. STAKES SHOULD BE INSTALLED LEAVING 1/5 OF STAKE ABOVE GROUND.

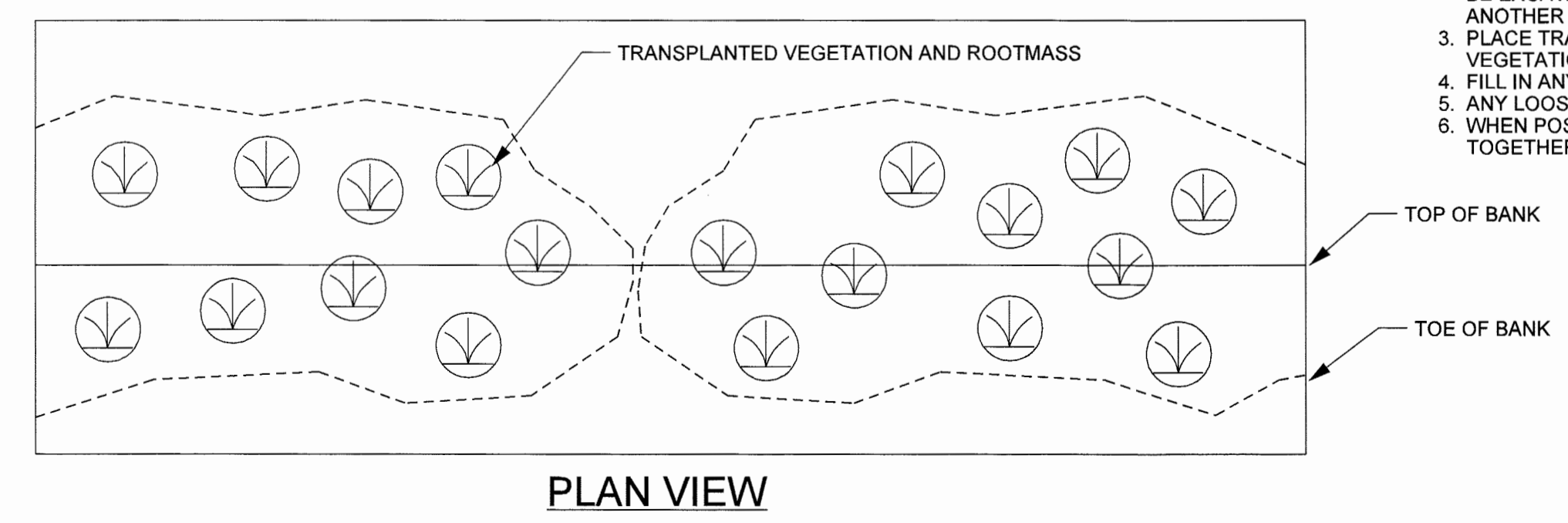
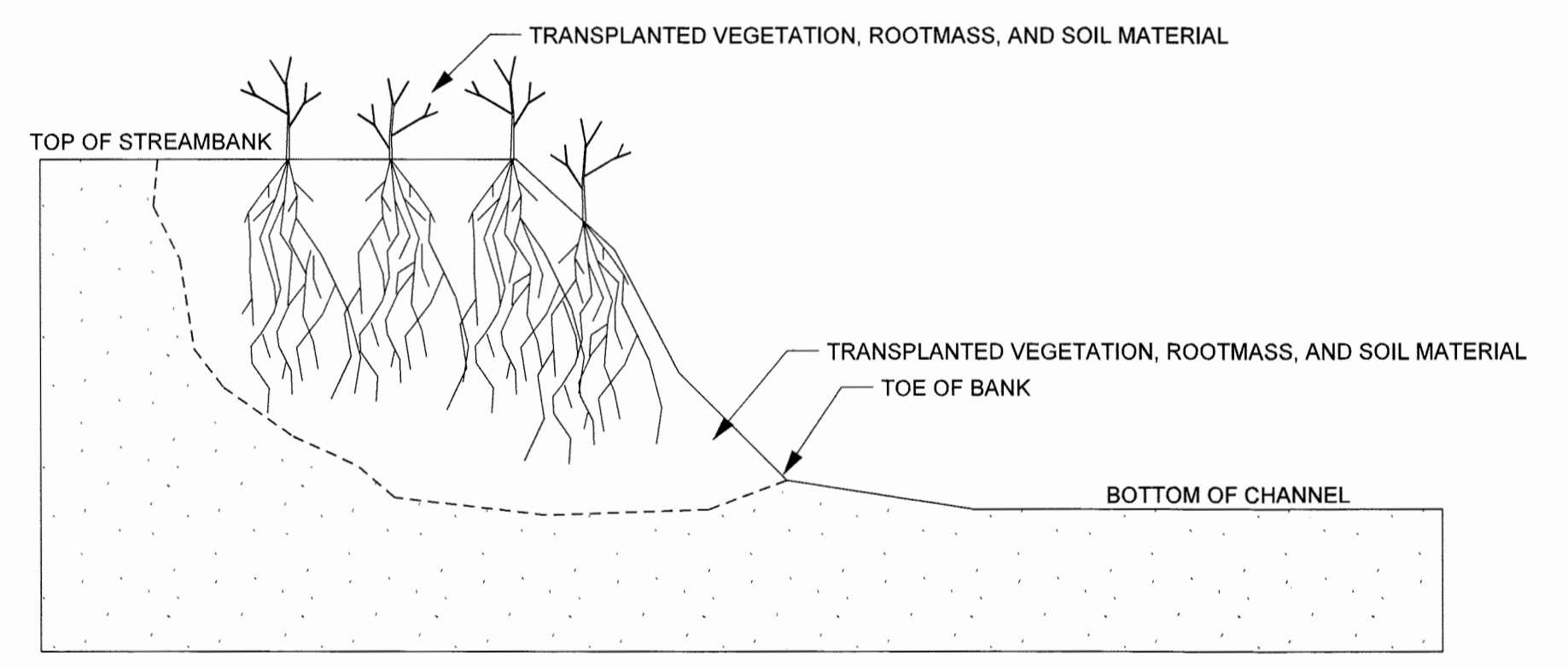
PLANTING SPECIFICATIONS



- NOTES:**
1. PLANT BARE ROOT SHRUBS AND TREES TO THE WIDTH OF THE BUFFER/PLANTING ZONE AS SHOWN ON THE PLANS.
 2. ALLOW FOR 8-10 FEET BETWEEN PLANTINGS, DEPENDING ON SIZE.
 3. LOOSEN COMPACTED SOIL.
 4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR, OR OTHER APPROVED MEANS.
 5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
 6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP, OR STRAW.
 7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO PROJECT SITE.

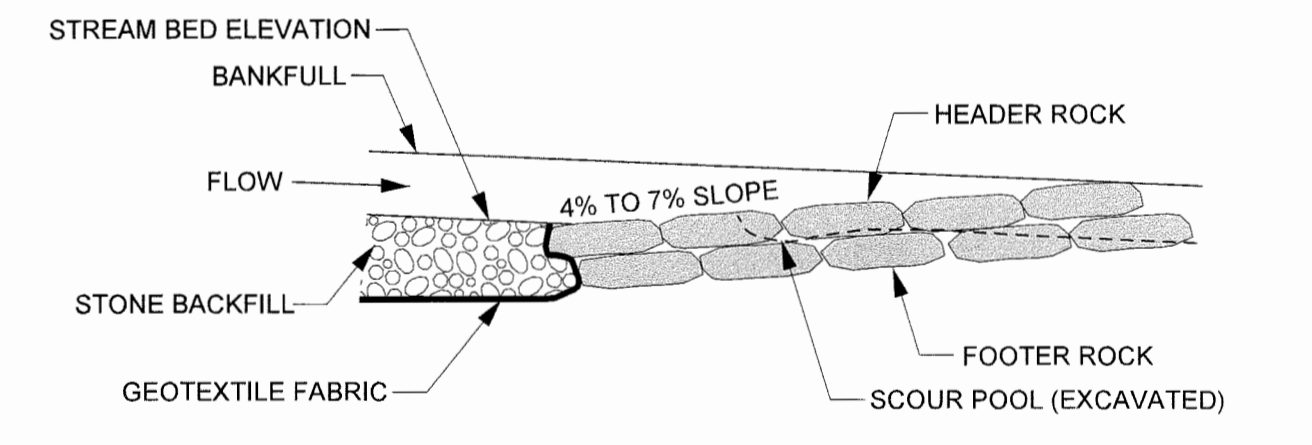
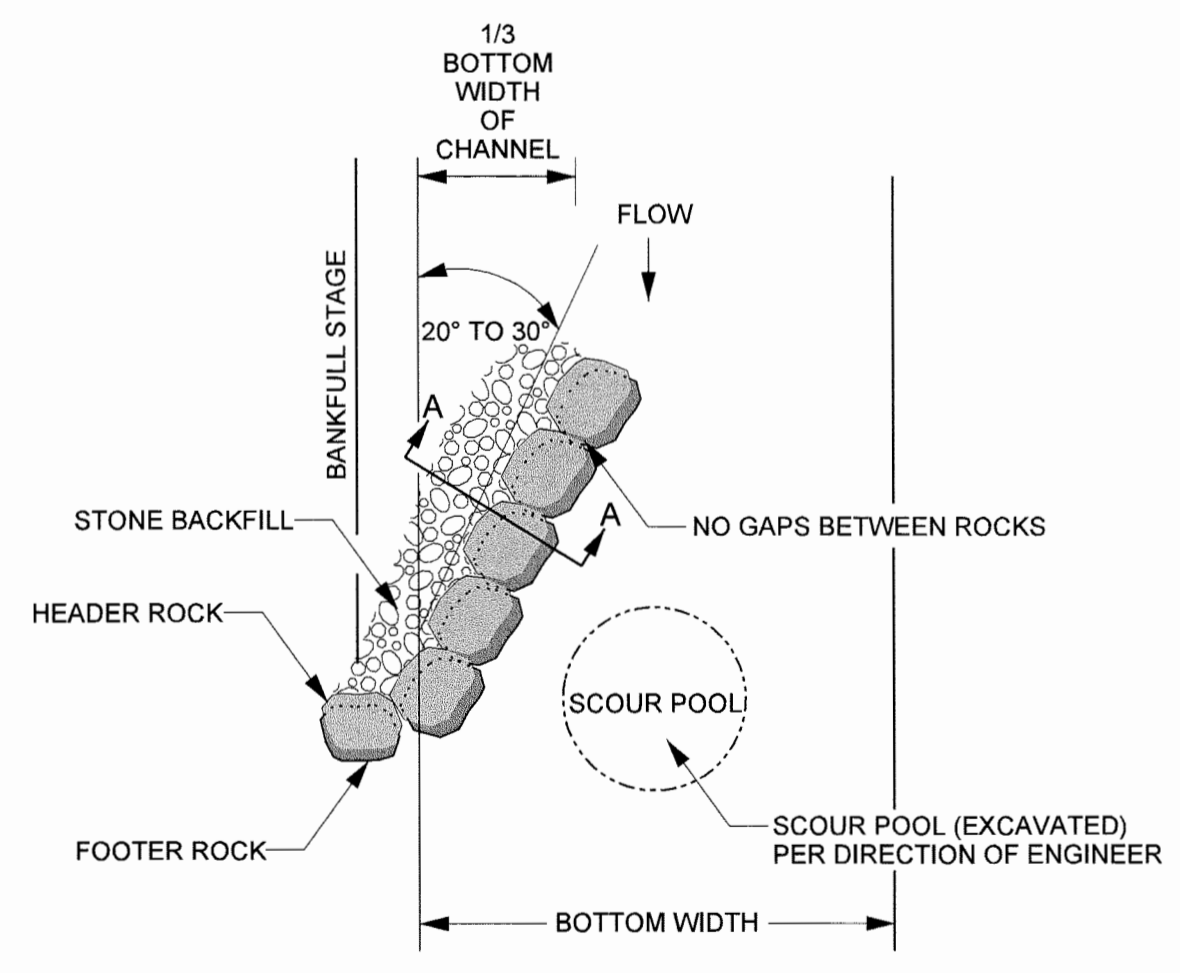
BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 2-A
PROJECT ENGINEER	
	APPROVED BY: <i>[Signature]</i>
	DATE: 2/29/16
Michael Baker International Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 900 Cary, NORTH CAROLINA 27518 Phone: 919.483.5488 Fax: 919.483.5490 License # F-1084	
NCDMS ID No. 96074	

TRANSPLANTED VEGETATION

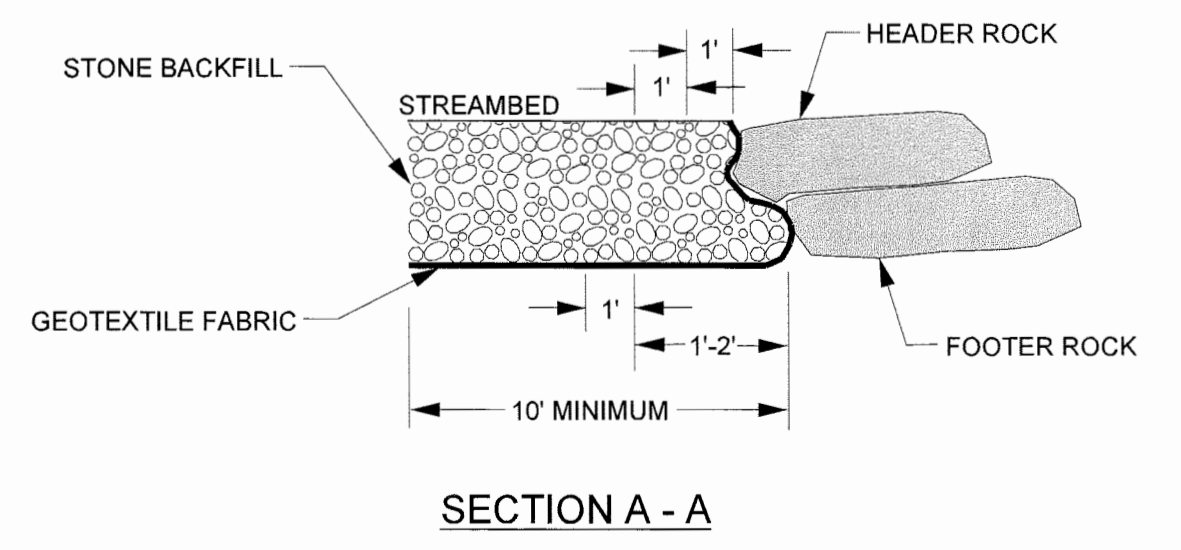


- NOTES:**
1. EXCAVATE A HOLE IN THE BANK TO BE STABILIZED THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLACED. BEGIN EXCAVATION AT THE TOE OF THE BANK.
 2. EXCAVATE THE ENTIRE ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
 3. PLACE TRANSPLANT IN THE BANK TO BE STABILIZED SO THAT VEGETATION IS ORIENTATED VERTICALLY.
 4. FILL IN ANY HOLES AROUND THE TRANSPLANT AND COMPACT.
 5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
 6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEY TOUCH.

ROCK VANE

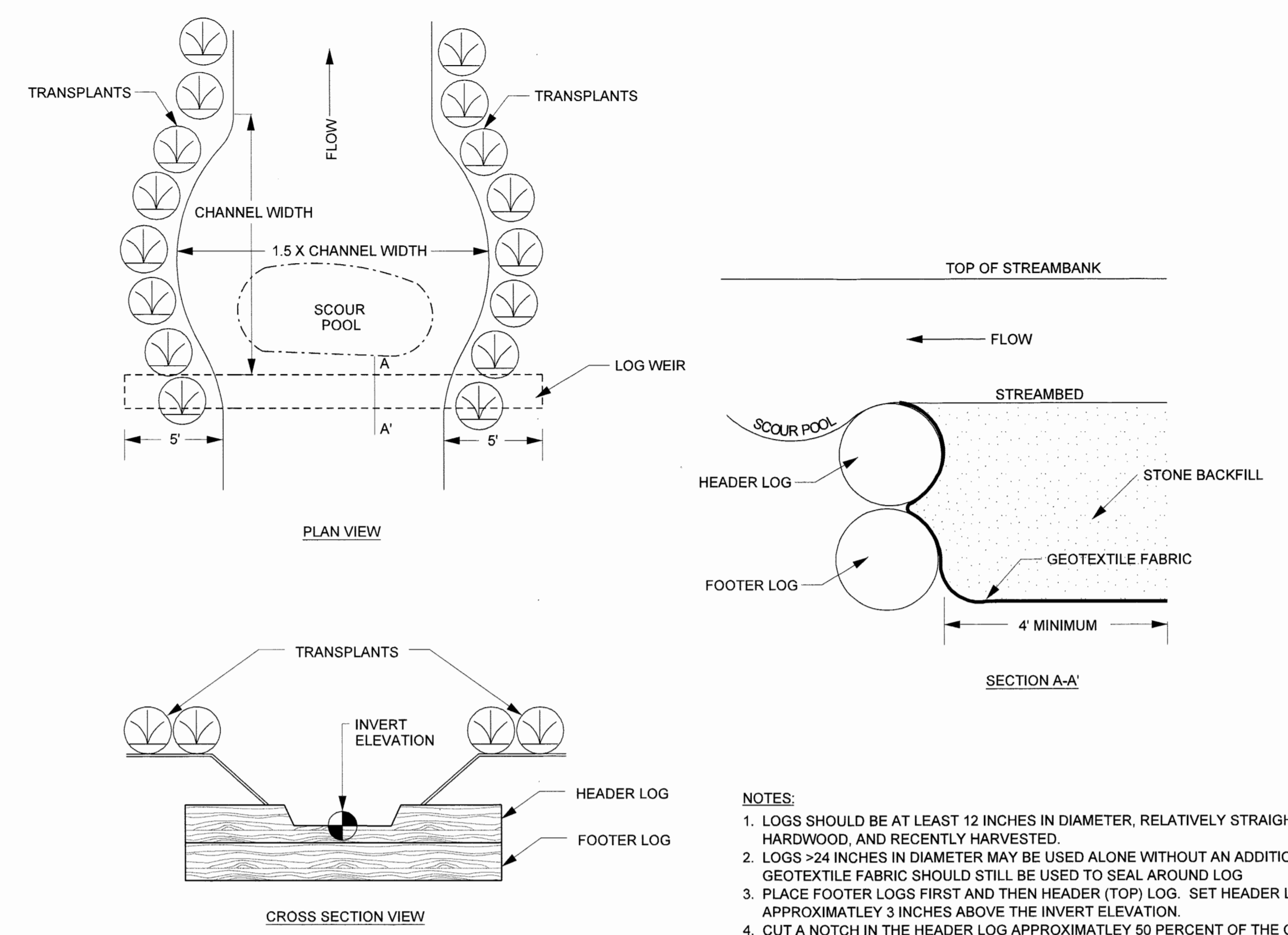


- NOTES FOR ALL VANE STRUCTURES:**
1. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER ROCKS AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER ROCK, AND THEN UPSTREAM TO A MINIMUM OF TEN FEET.
 2. DIG A TRENCH BELOW THE BED FOR FOOTER ROCKS AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
 3. START AT BANK AND PLACE FOOTER ROCKS FIRST AND THEN HEADER (TOP) ROCK.
 4. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
 5. AN EXTRA ROCK CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT.
 6. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER ROCKS.
 7. AFTER ALL STONE BACKFILL HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF THE TOP OF THE HEADER ROCK.
 8. START SLOPE AT 2/3 TO 1 TIMES THE BANKFULL STAGE.



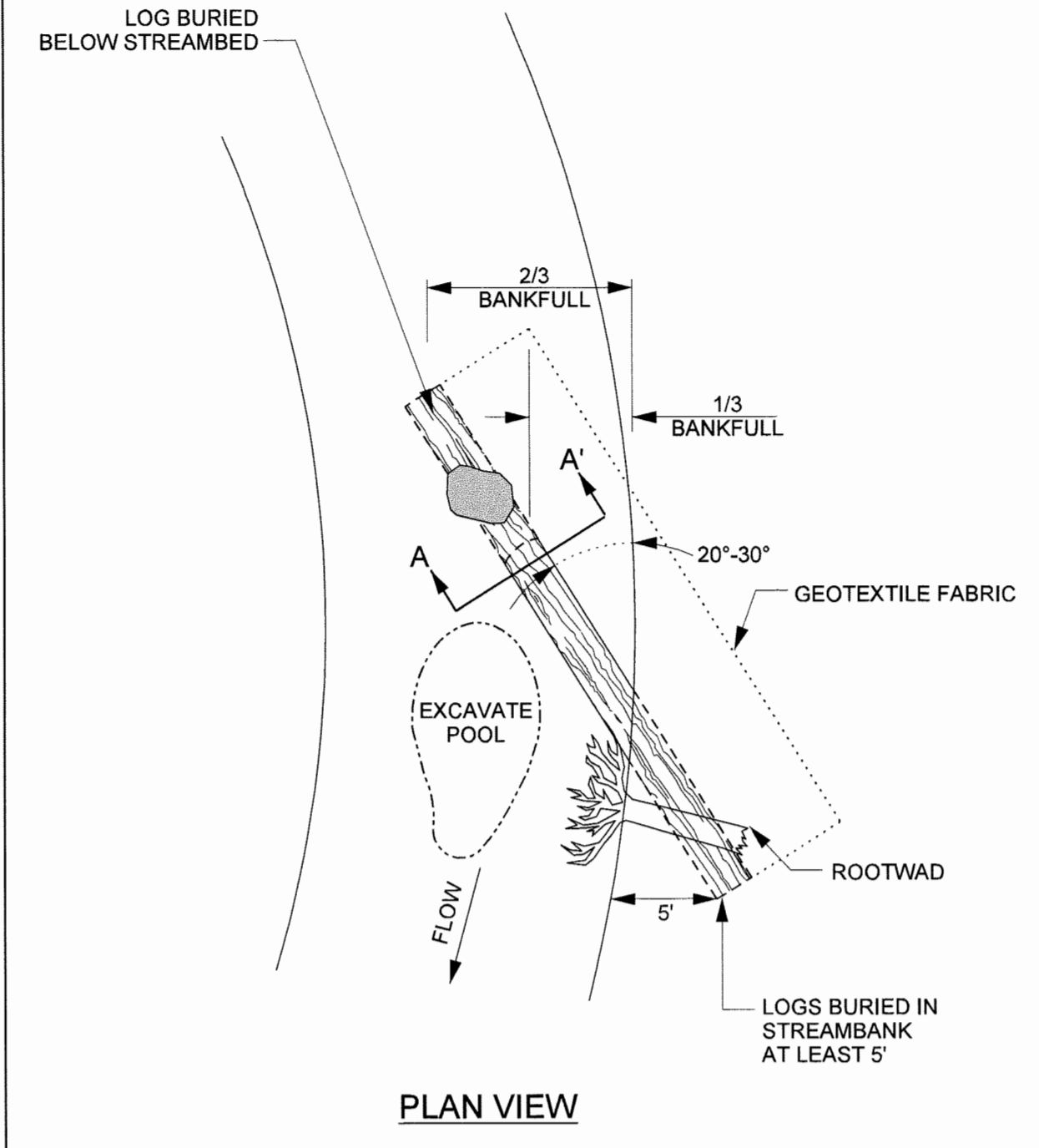
2/26/03

LOG WEIR

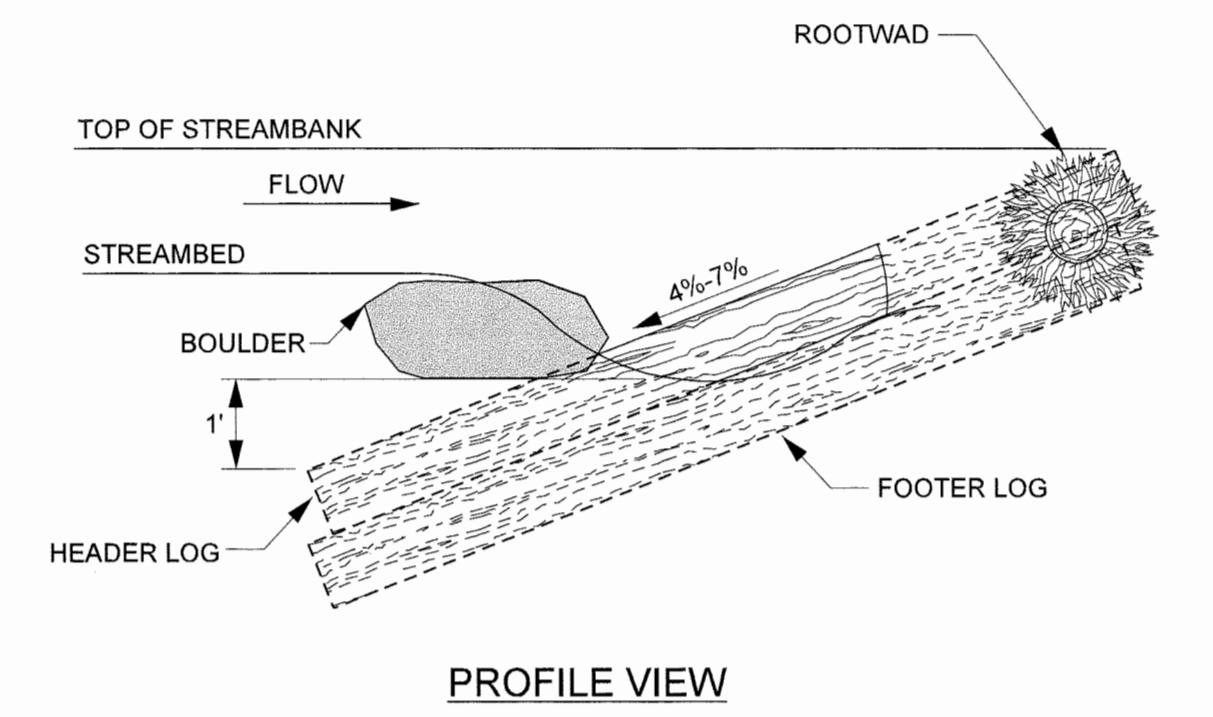
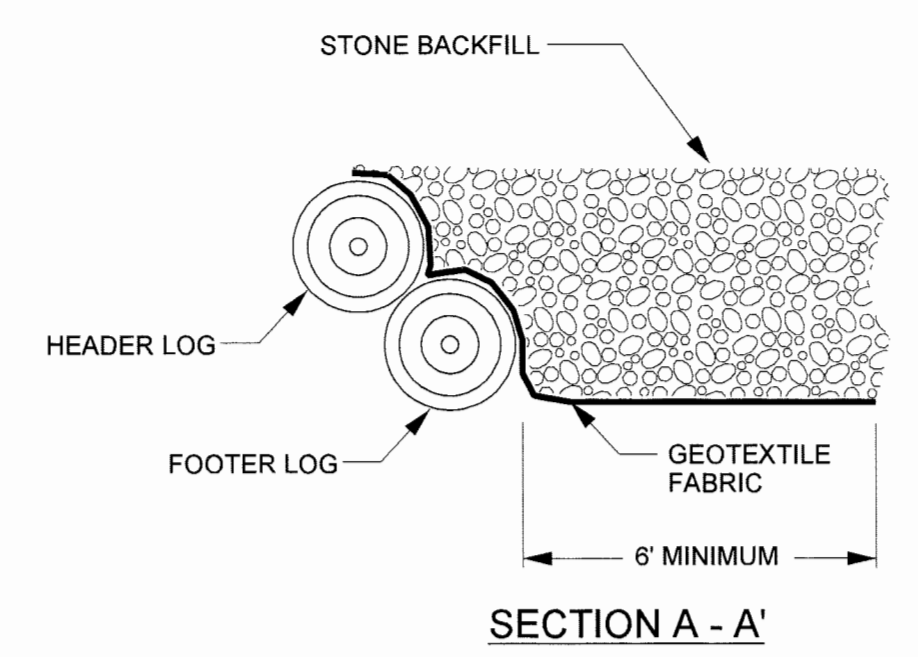


- NOTES:**
- LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
 - LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG. GEOTEXTILE FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG
 - PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG APPROXIMATELY 3 INCHES ABOVE THE INVERT ELEVATION.
 - CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 50 PERCENT OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION.
 - USE GEOTEXTILE FABRIC TO SEAL GAPS BETWEEN LOGS.
 - PLACE TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.

LOG VANE

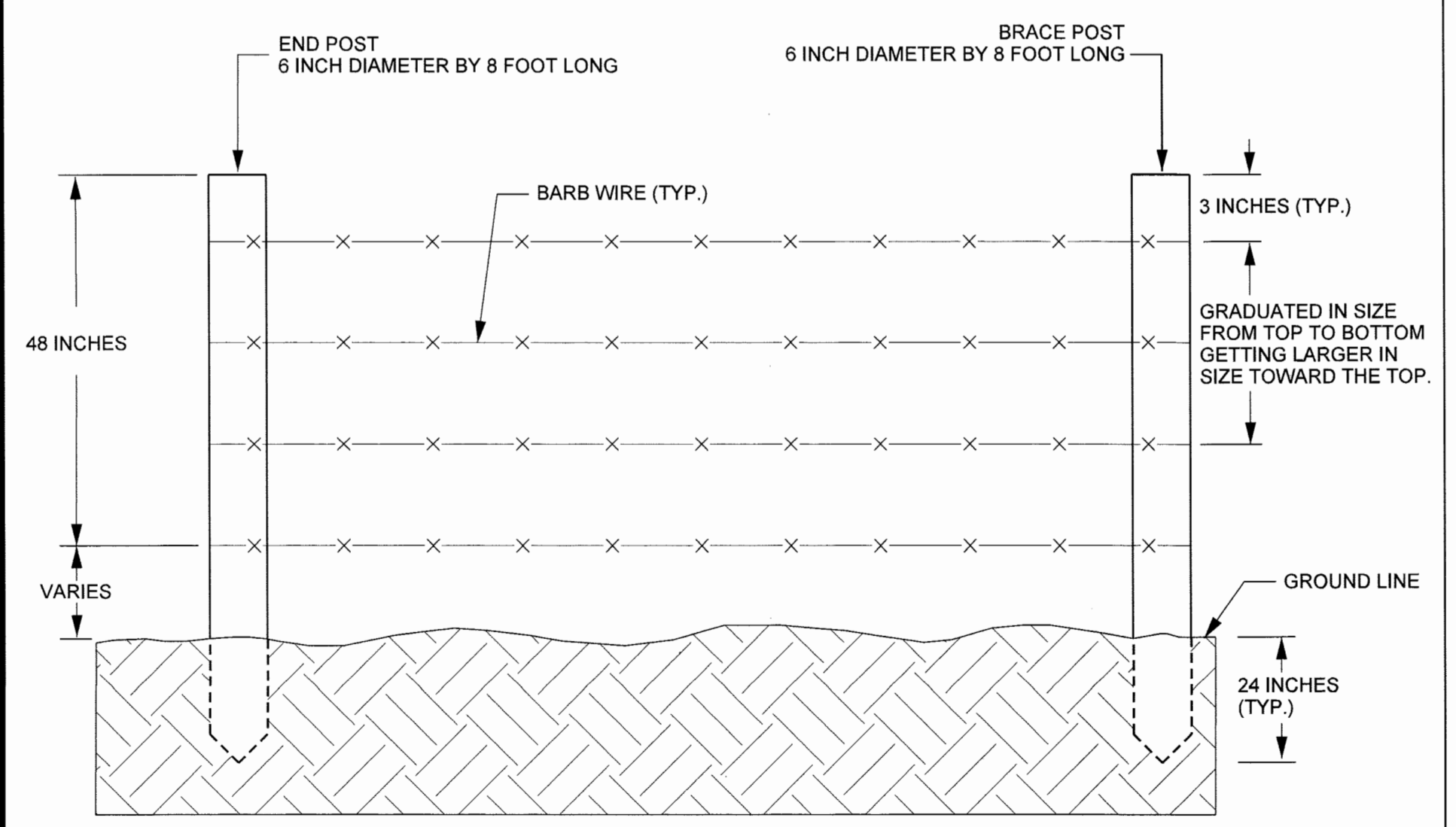


- NOTES:**
- LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
 - BOULDERS MUST BE OF SUFFICIENT SIZE TO ANCHOR LOGS.
 - SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
 - ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
 - BOULDER SHOULD BE PLACED ON TOP OF HEADER LOG FOR ANCHORING.
 - GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
 - TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.



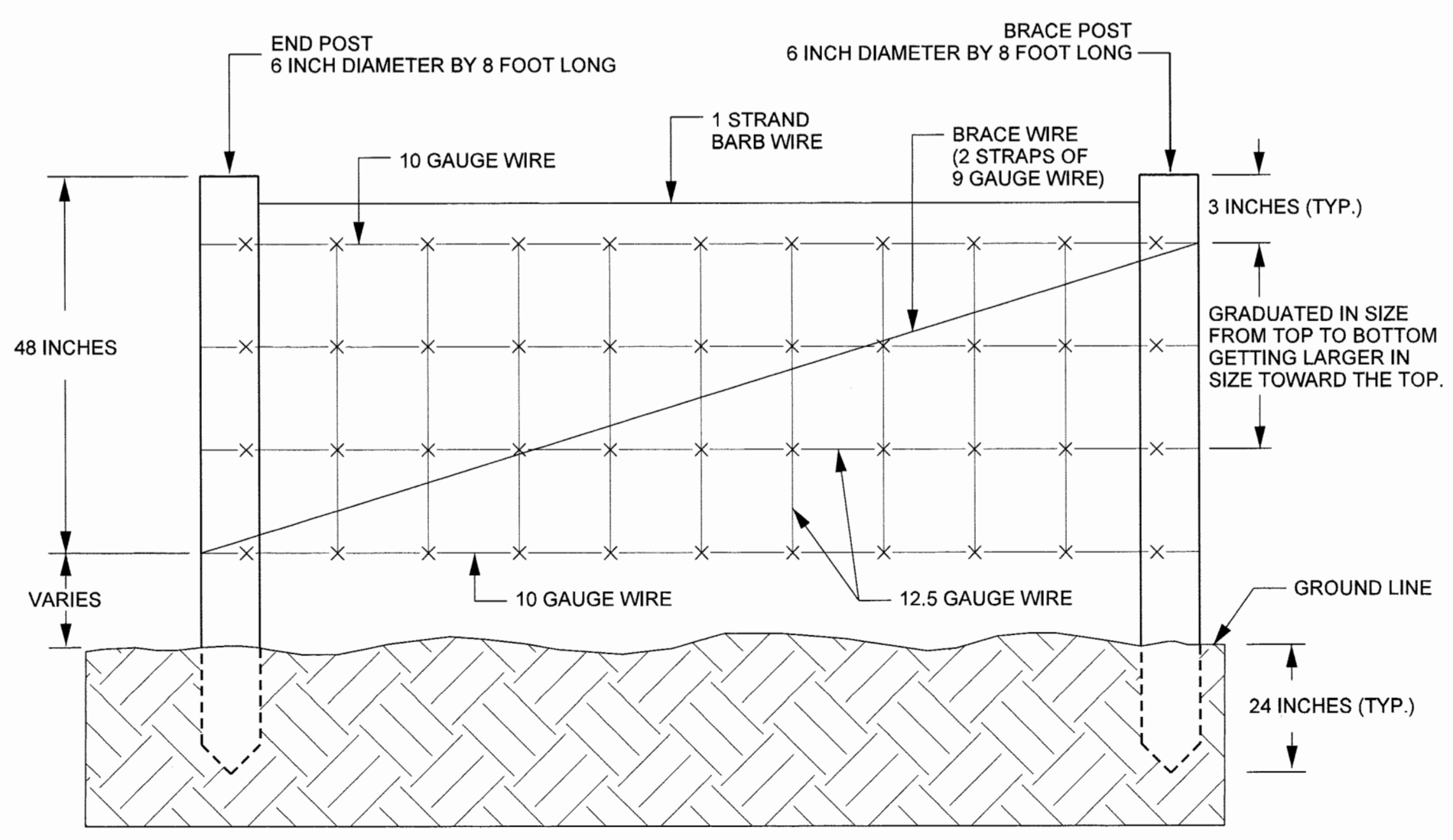
BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 2-B
PROJECT ENGINEER	
APPROVED BY: 	
DATE: 9/29/16	
Michael Baker International	
Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1084	
NCDMS ID No. 96074	

BARB WIRE FIELD FENCE



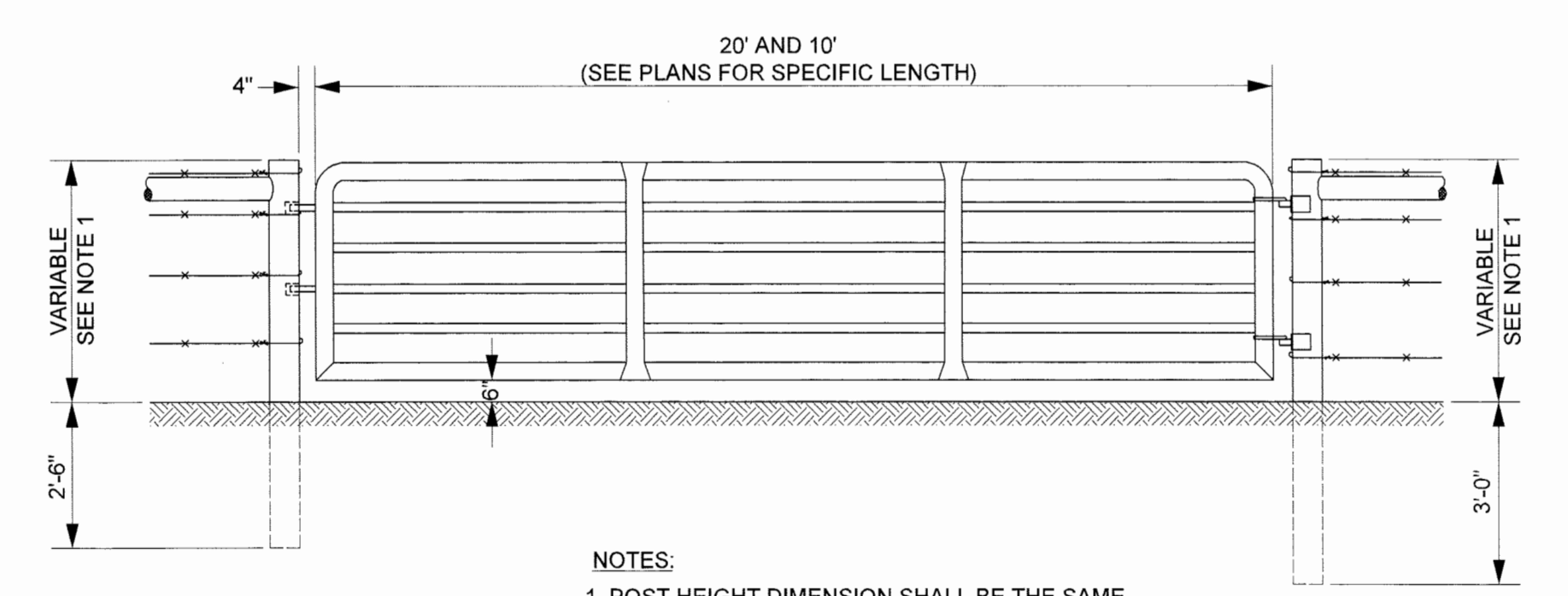
- NOTE:**
- END POSTS SHALL BE INSTALLED AT A SPACING OF 10-15 FEET.

WOVEN WIRE FIELD FENCE



- NOTE:**
- END POSTS SHALL BE INSTALLED AT A SPACING OF 8 FEET BETWEEN POSTS, NOT ON CENTER.
 - DUAL WOODEN POST TURN NEEDED IF CHANGE IN FENCE ANGLE IS >20 DEGREES.
 - LINE POSTS SPACED LESS THAN 16.5 FEET APART.

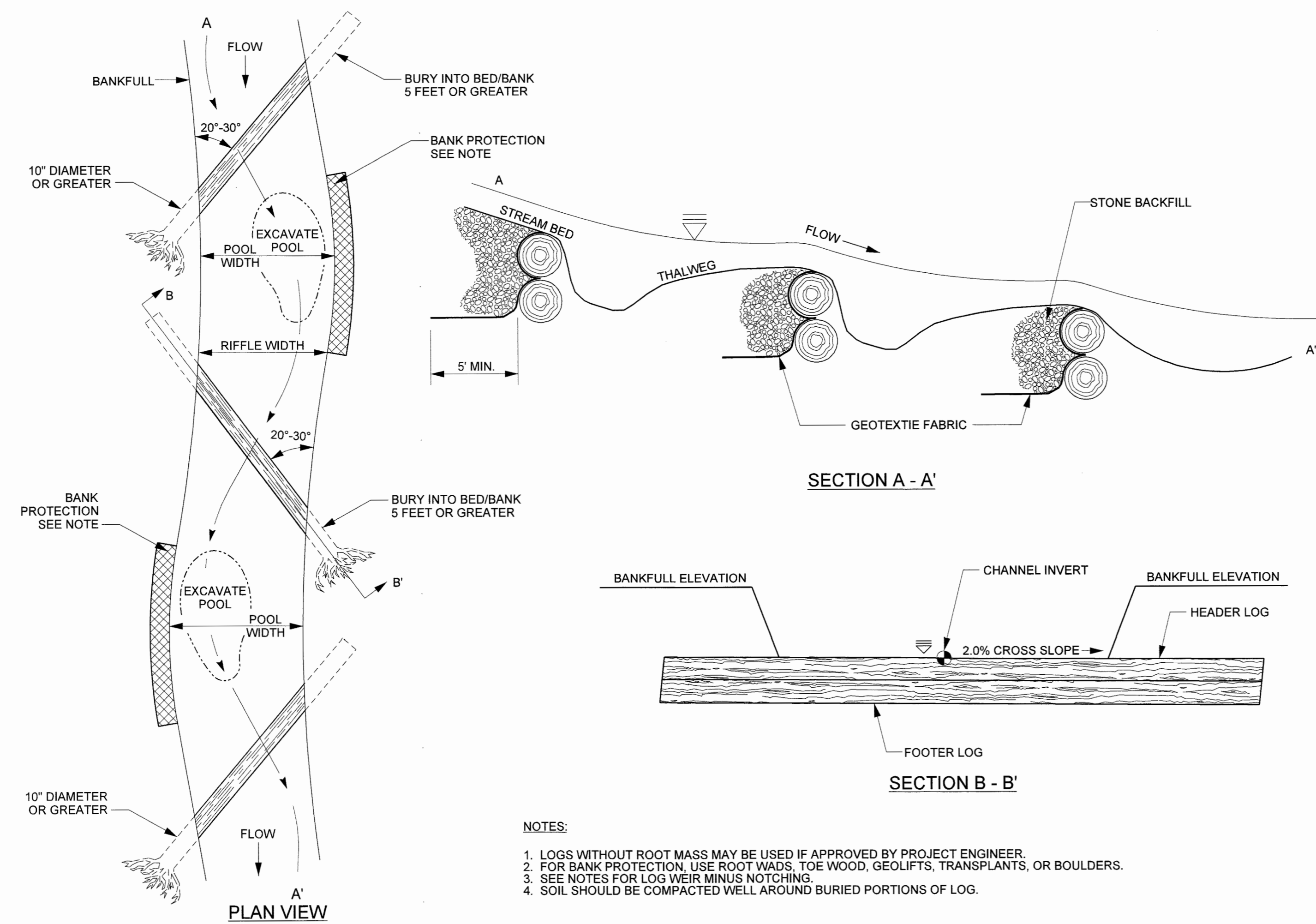
STEEL FRAME GATES



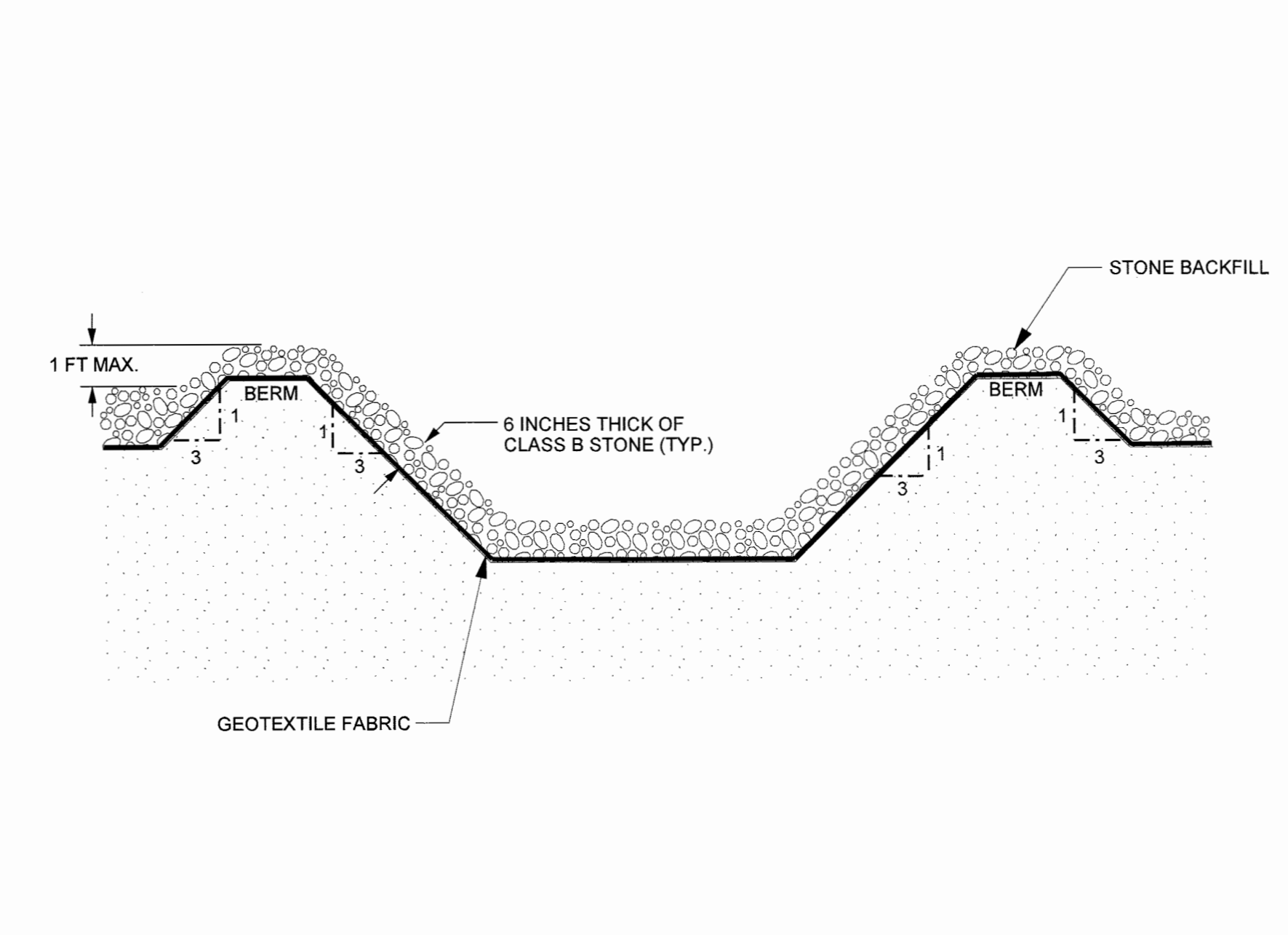
- NOTES:**
- POST HEIGHT DIMENSION SHALL BE THE SAME AS REQUIRED FOR THE ADJACENT FENCE.
 - CONSTRUCT AN END OR STRESS PANEL AS REQUIRED IN THE SPECIFICATION, ON EACH SIDE OF GATE.
 - HINGES AND LOCKS SHALL BE INSTALLED AS SPECIFIED BY GATE MANUFACTURER.

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LOG STEP POOL

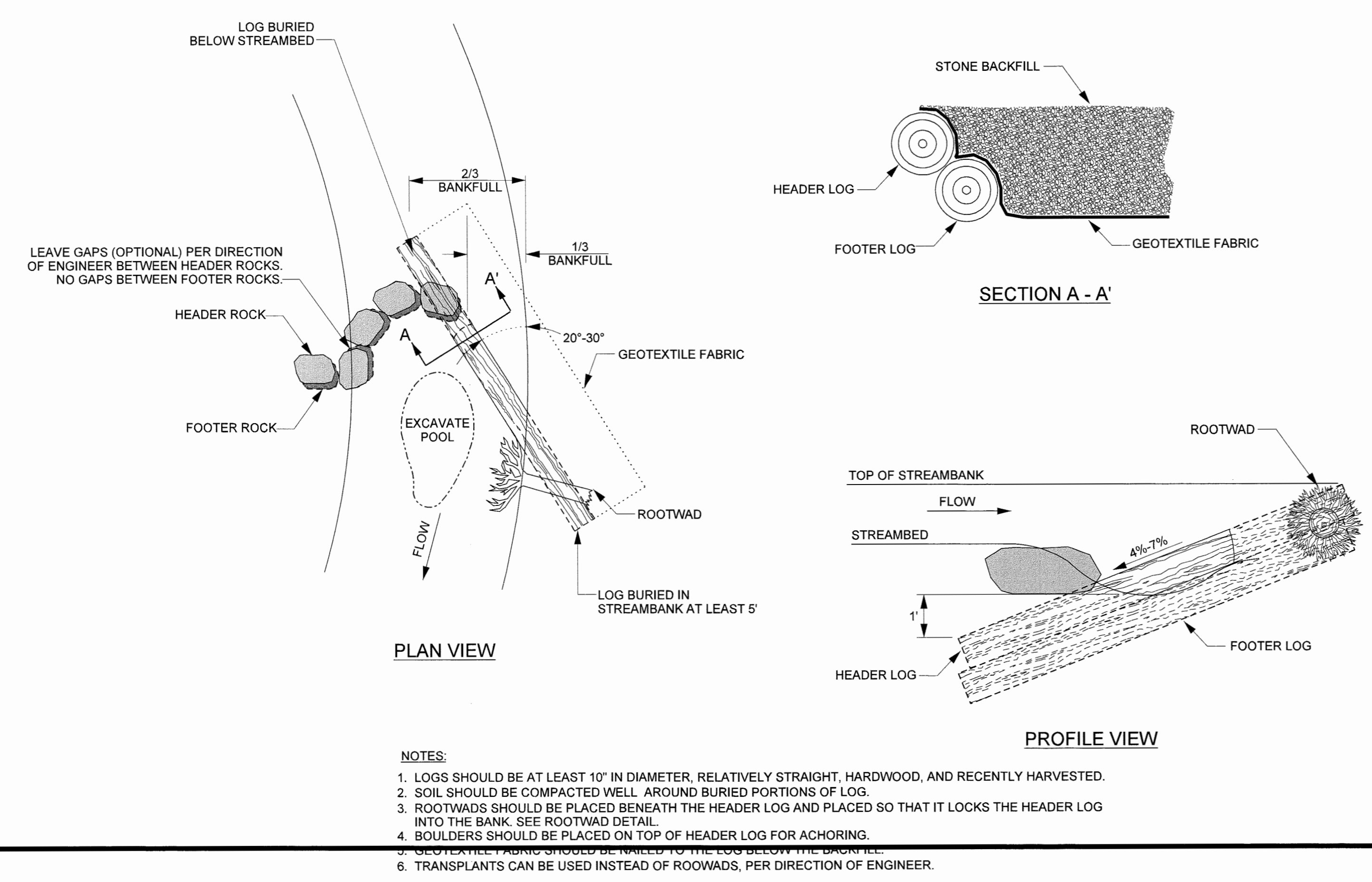


PERMANENT FORD STREAM CROSSING

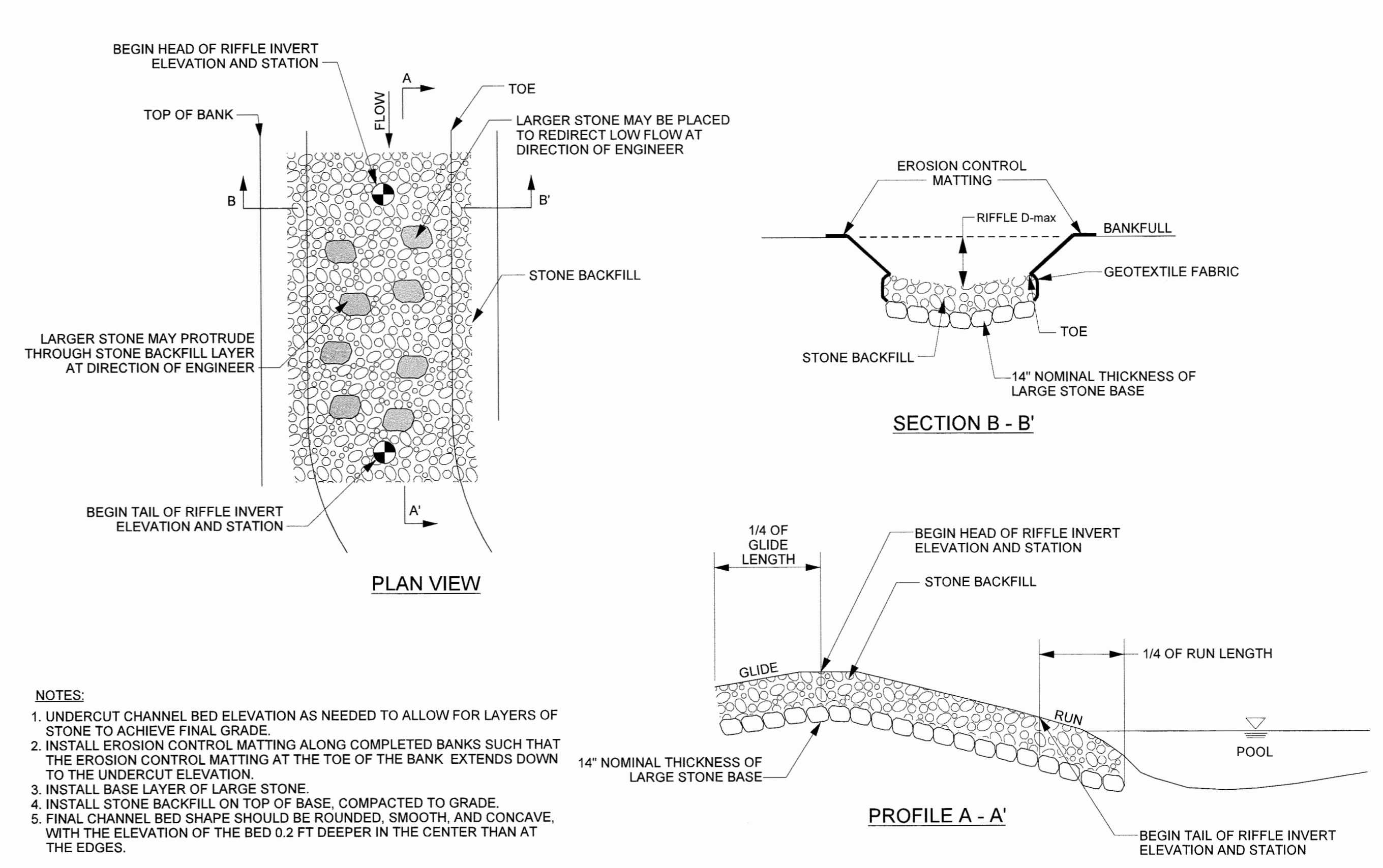


- NOTES:**
- CONSTRUCT STREAM CROSSING WHEN FLOW IS LOW.
 - HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
 - MINIMIZE CLEARING AND EXCAVATION OF STREAMBANKS. DO NOT EXCAVATE CHANNEL BOTTOM. COMPLETE ONE SIDE BEFORE STARTING ON THE OTHER SIDE.
 - INSTALL STREAM CROSSING AT RIGHT ANGLE TO THE FLOW.
 - GRADE SLOPES TO A 3:1 SLOPE. TRANSPLANT SOD FROM ORIGINAL STREAMBANK ONTO SIDE SLOPES.
 - MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL.
 - A STABILIZED PAD OF STONE BACKFILL, 6 INCHES THICK, LINED WITH GEOTEXTILE FABRIC, SHALL BE USED OVER THE BERM AND ACCESS SLOPES.
 - WIDTH OF THE CROSSING SHALL BE SUFFICIENT TO ACCOMMODATE THE LARGEST VEHICLE CROSSING THE CHANNEL.
 - CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED.

GRADE CONTROL LOG J-HOOK VANE



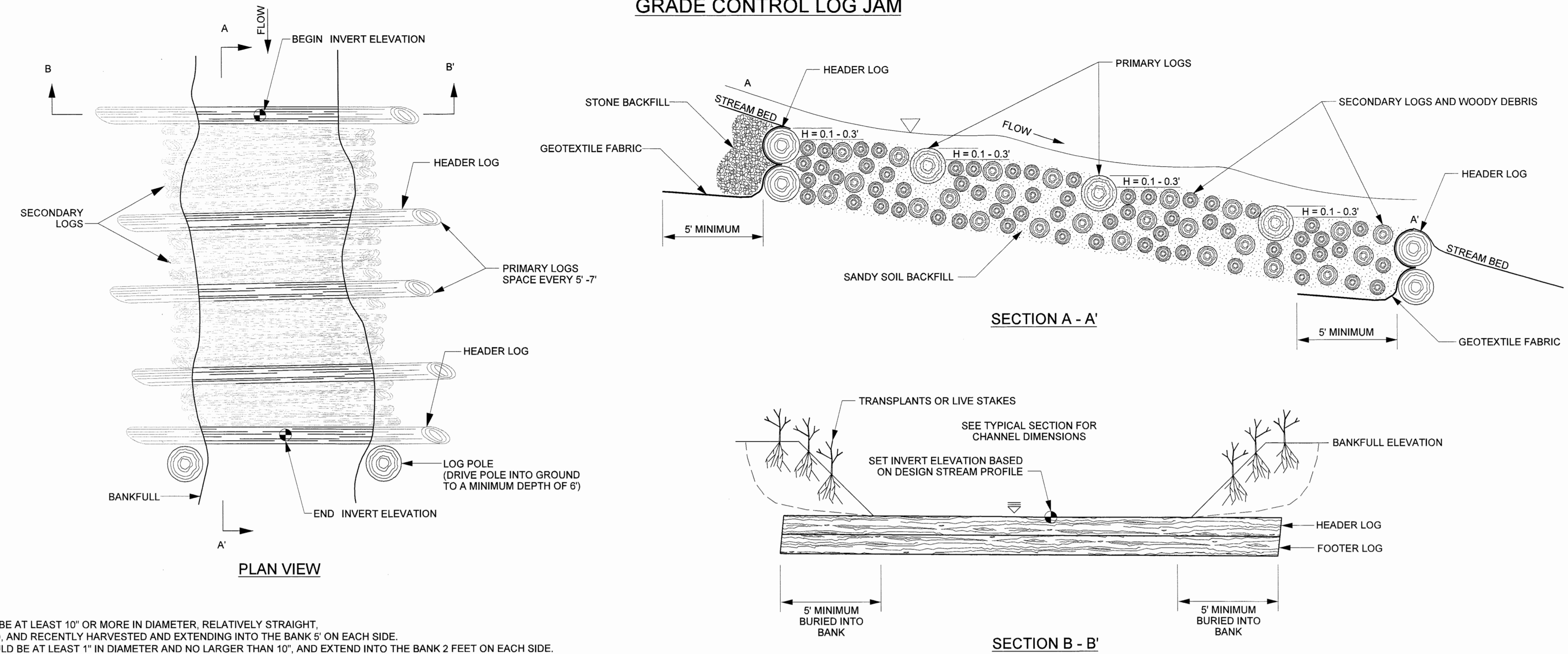
CONSTRUCTED RIFFLE WITH LARGE STONE BASE



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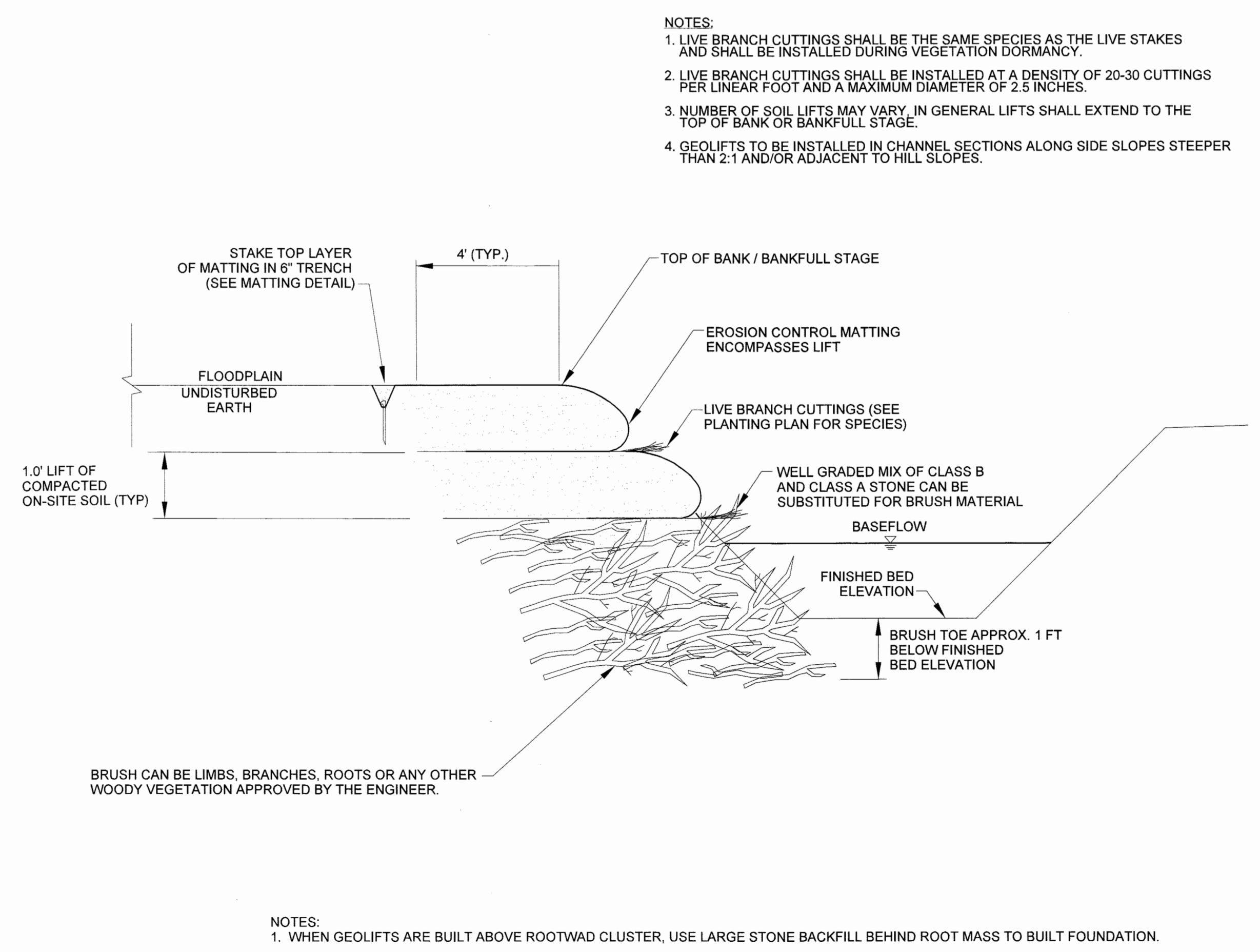
GRADE CONTROL LOG JAM



- NOTES:**
1. PRIMARY LOGS SHOULD BE AT LEAST 10" OR MORE IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD PREFERRED, AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
 2. SECONDARY LOGS SHOULD BE AT LEAST 1" IN DIAMETER AND NO LARGER THAN 10", AND EXTEND INTO THE BANK 2 FEET ON EACH SIDE. WOOD MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
 3. VERTICAL POSTS SHOULD BE AT LEAST 10" IN DIAMETER AND SHOULD BE DRIVEN INTO THE GROUND A MINIMUM OF 6'.
 4. FILTER FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
 5. ROOTWADS AND COIR FIBER MATTING CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES. PER DIRECTION OF ENGINEER.
 6. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.

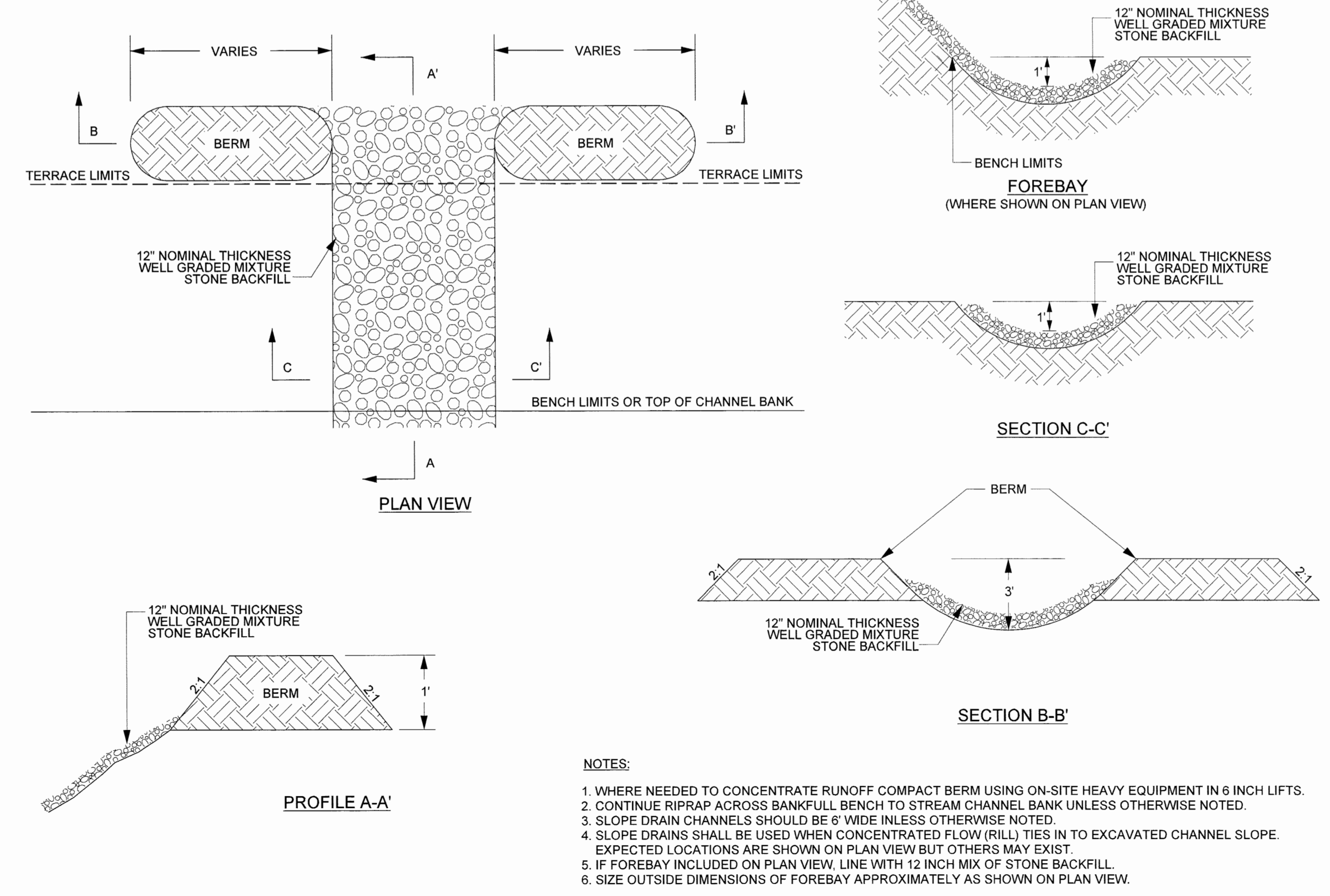
BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 2-D
PROJECT ENGINEER	
APPROVED BY: 	
DATE: 9/29/16	
Michael Baker International 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.463.5485 Fax: 919.463.6490 License # F-1084	
NCDMS ID No. 96074	

GEOLIFT WITH BRUSH TOE



- NOTES:**
1. WHEN GEOLIFTS ARE BUILT ABOVE ROOTWAD CLUSTER, USE LARGE STONE BACKFILL BEHIND ROOT MASS TO BUILT FOUNDATION.

SLOPE DRAIN

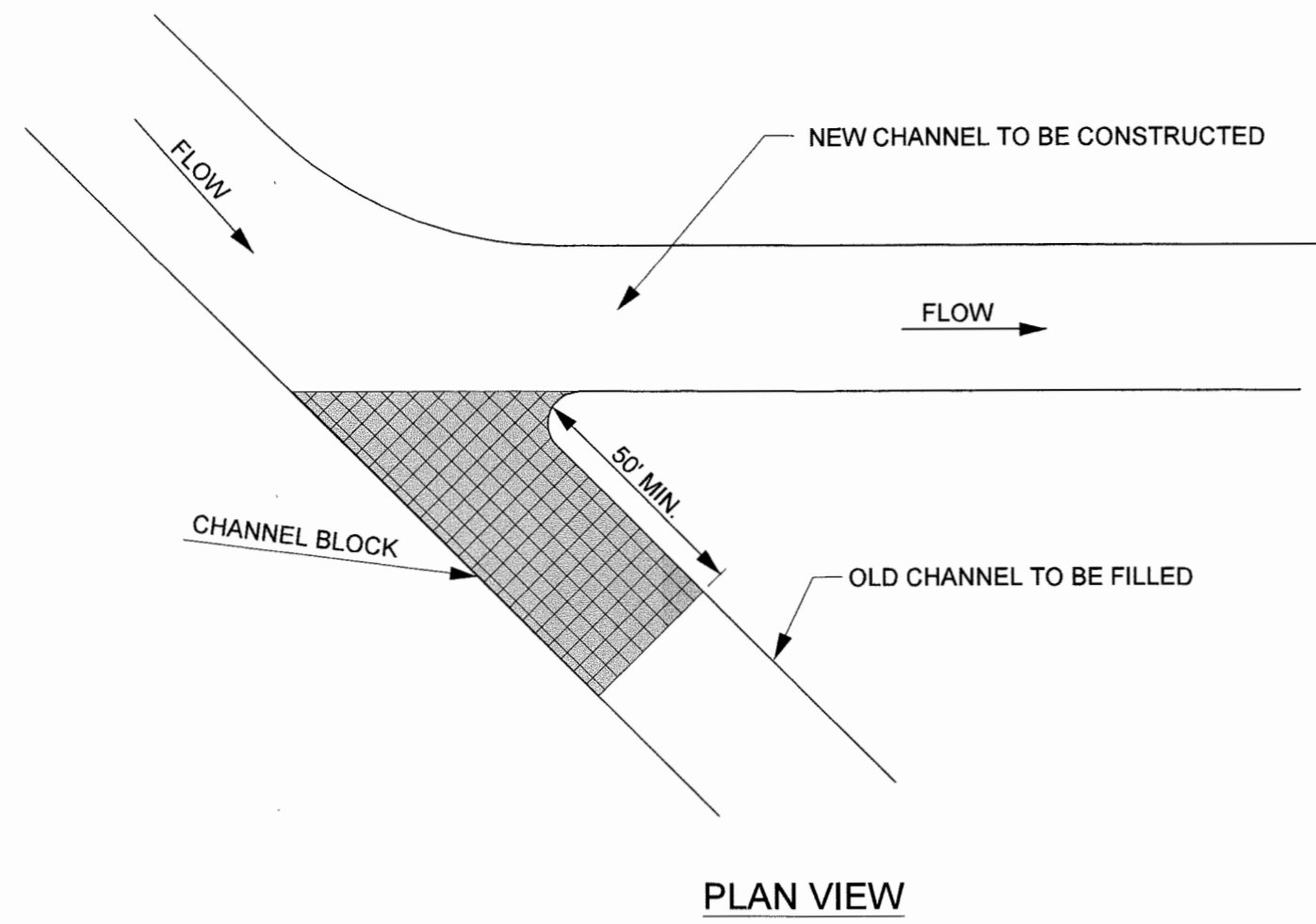


- NOTES:**
1. WHERE NEEDED TO CONCENTRATE RUNOFF COMPACT BERM USING ON-SITE HEAVY EQUIPMENT IN 6 INCH LIFTS.
 2. CONTINUE RIPRAP ACROSS BANKFULL BENCH TO STREAM CHANNEL BANK UNLESS OTHERWISE NOTED.
 3. SLOPE DRAIN CHANNELS SHOULD BE 6' WIDE UNLESS OTHERWISE NOTED.
 4. SLOPE DRAINS SHALL BE USED WHEN CONCENTRATED FLOW (RILL) TIES IN TO EXCAVATED CHANNEL SLOPE. EXPECTED LOCATIONS ARE SHOWN ON PLAN VIEW BUT OTHERS MAY EXIST.
 5. IF FOREBAY INCLUDED ON PLAN VIEW, LINE WITH 12 INCH MIX OF STONE BACKFILL.
 6. SIZE OUTSIDE DIMENSIONS OF FOREBAY APPROXIMATELY AS SHOWN ON PLAN VIEW.

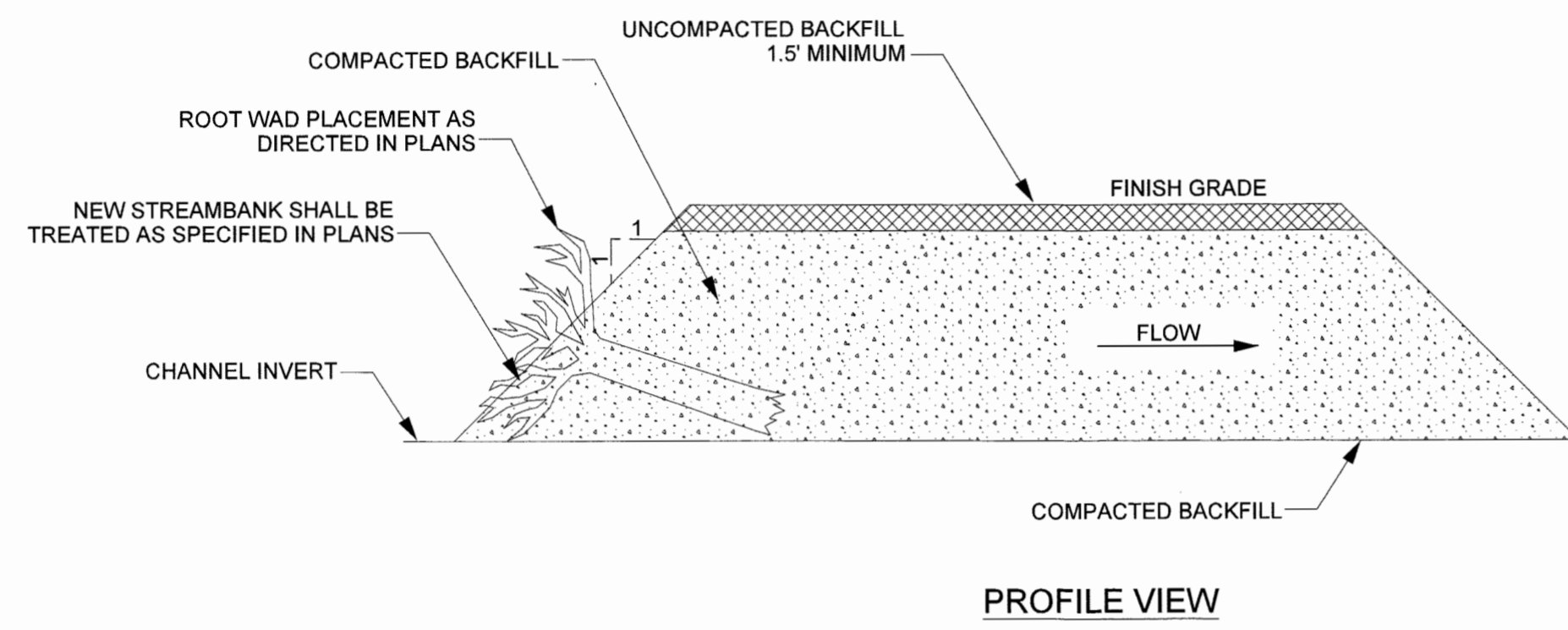
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2/26/03

CHANNEL BLOCK

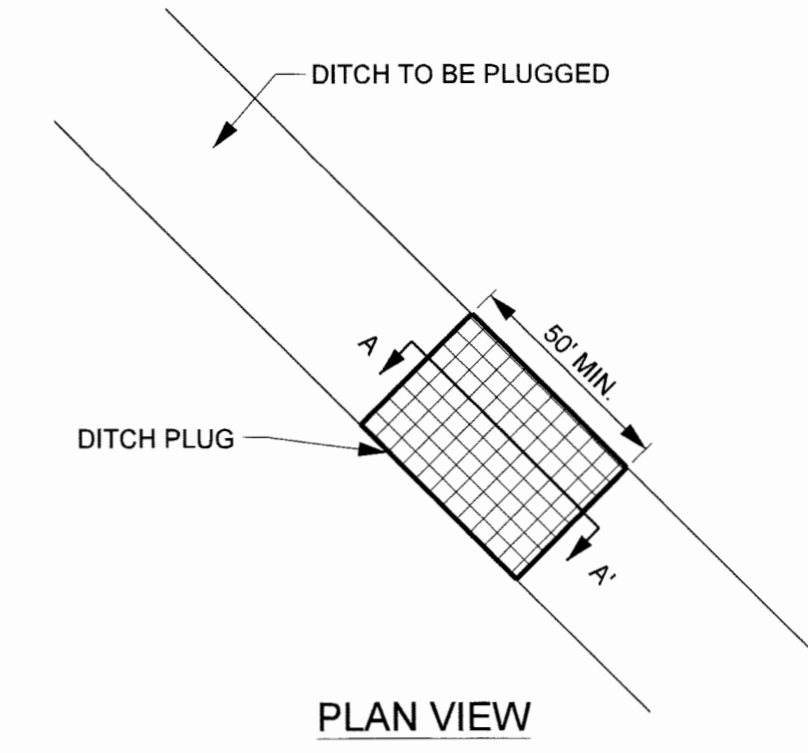


PLAN VIEW

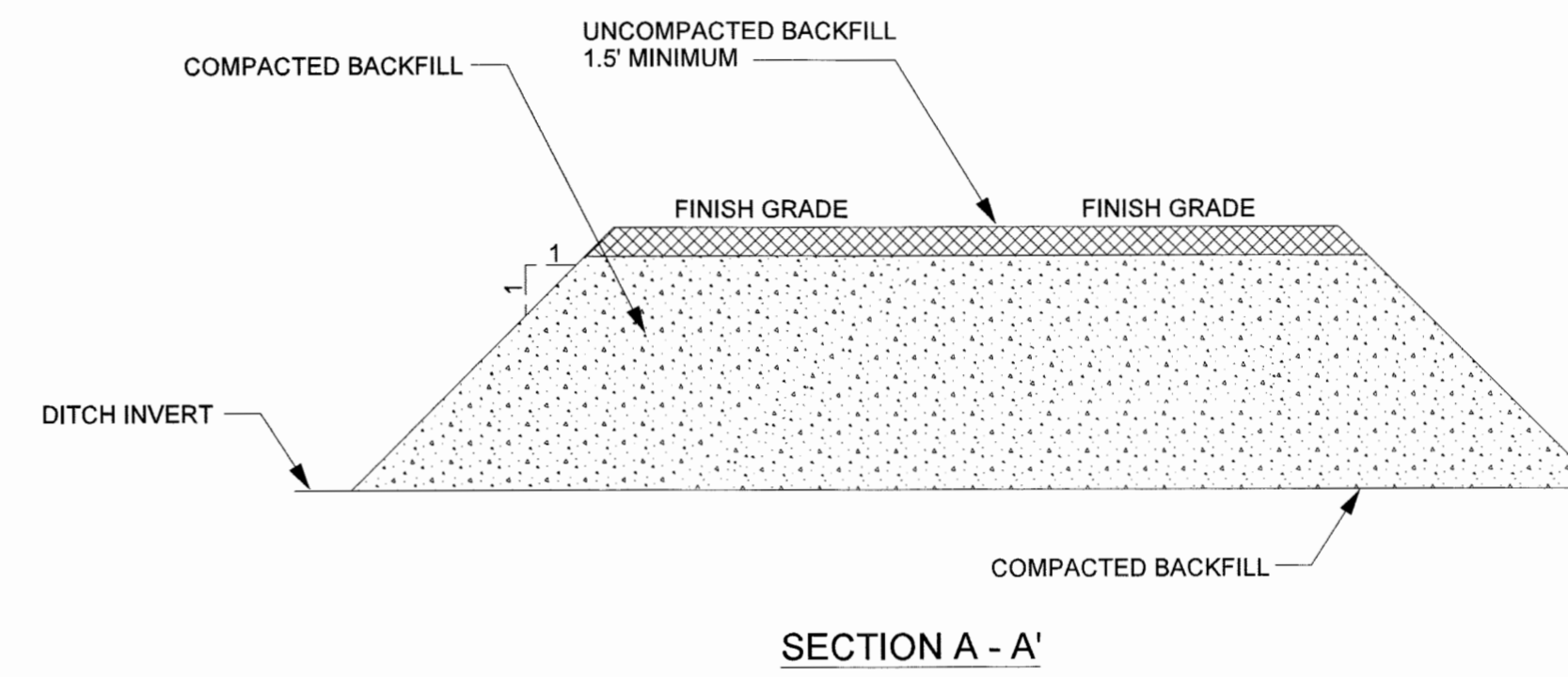


PROFILE VIEW

DITCH PLUG



PLAN VIEW



SECTION A - A'

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PROJECT ENGINEER	
APPROVED BY: <i>[Signature]</i>	
DATE: 2/29/16	
Michael Baker International	
<small>Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.463.5468 Fax: 919.463.5490 License #: F-1084</small>	
NCDMS ID No. 96074	

NOTE:
COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT
IN 10 INCH LIFTS.

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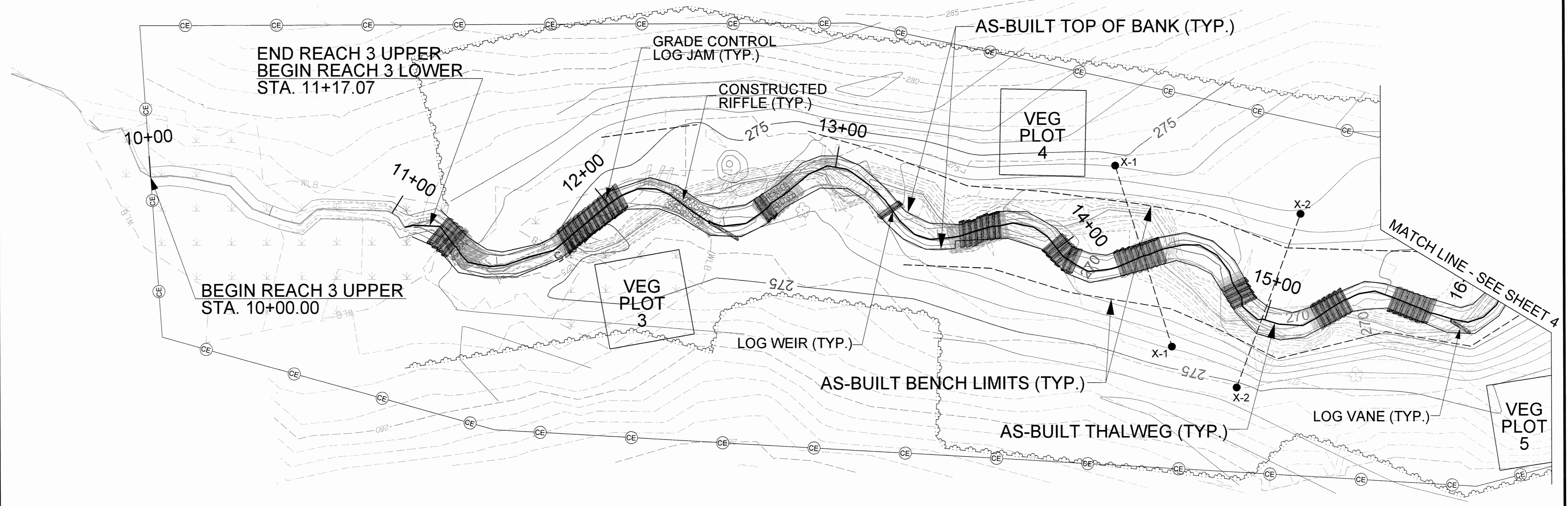
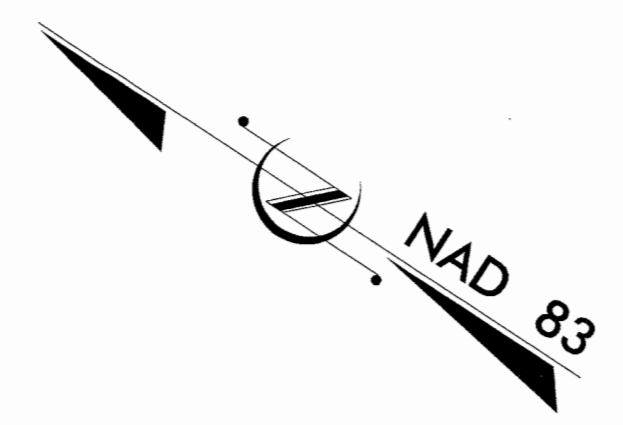
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	3
Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.483.5488 Fax: 919.483.5490 License #: F-1094	
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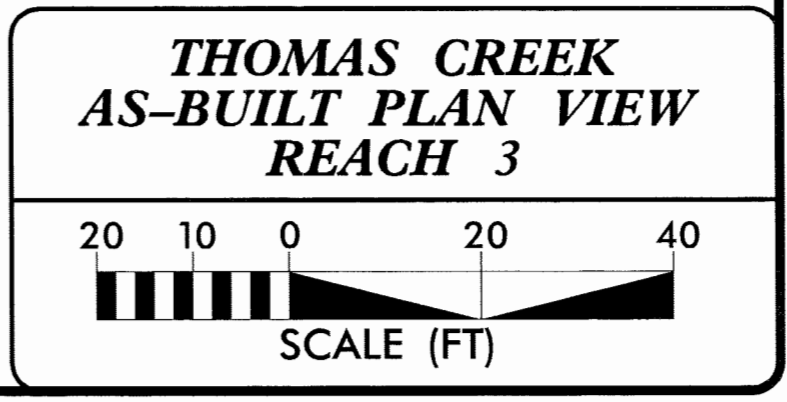


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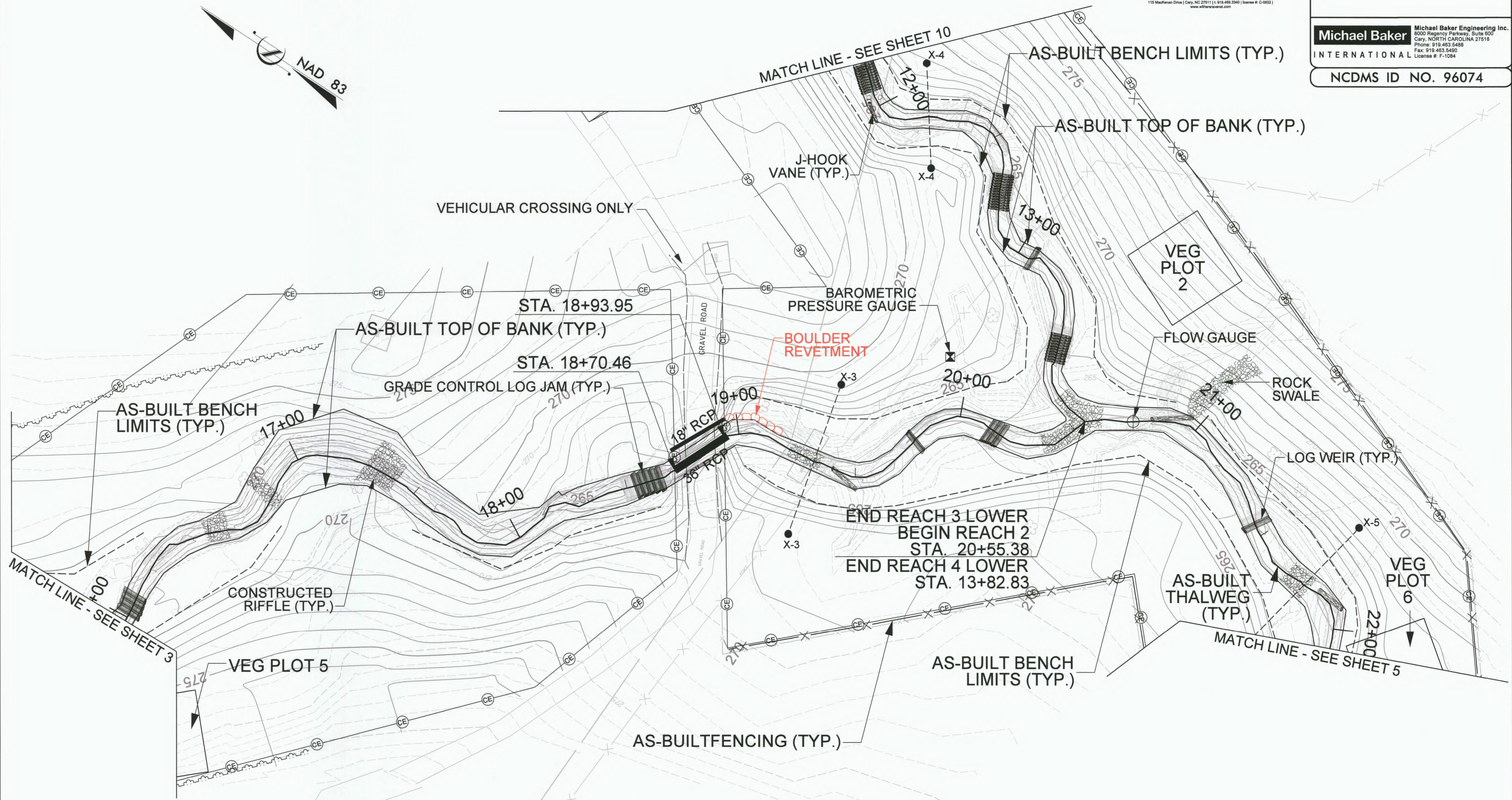
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Marshall Wight
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Michael Baker International Michael Baker Engineering Inc. 5000 Regency Parkway, Suite 500 Cary, NORTH CAROLINA 27518 Phone: 919.483.5488 Fax: 919.483.5490 License #: F-1084	
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**THOMAS CREEK
AS-BUILT PLAN VIEW
REACH 3, 2, & 4**

SCALE (FT)

2/26/03

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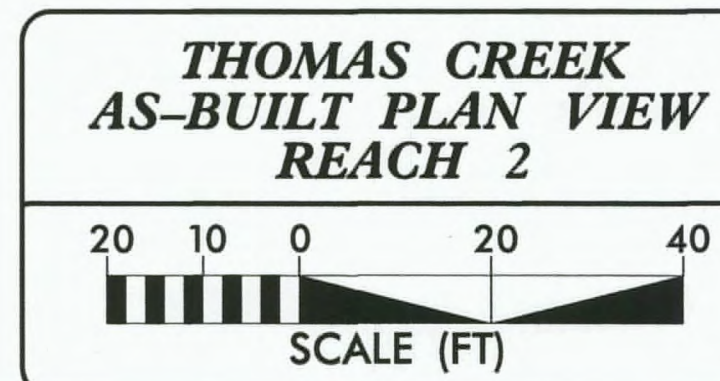
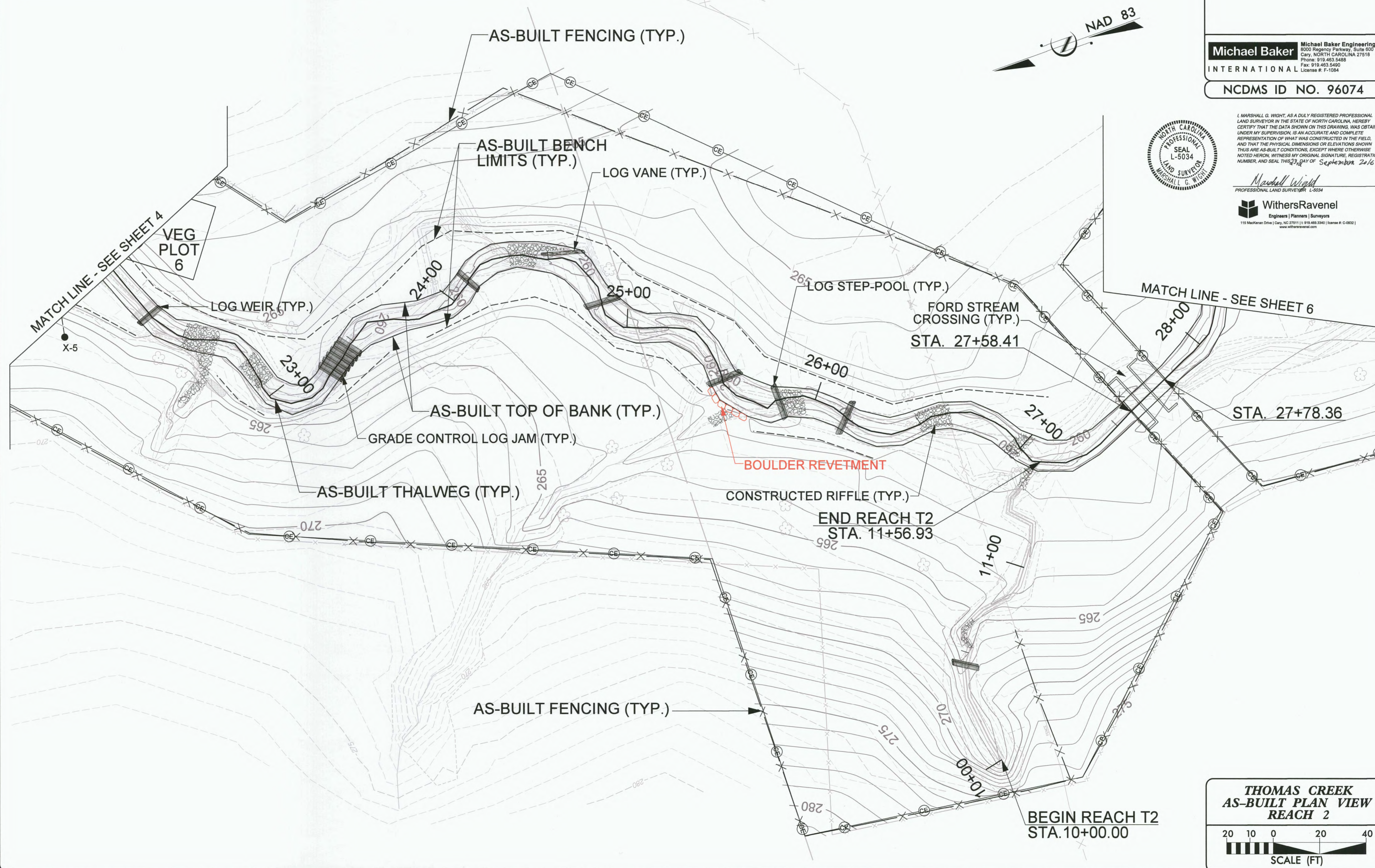
NCDMS ID NO. 96074



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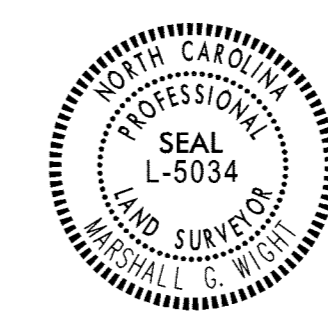
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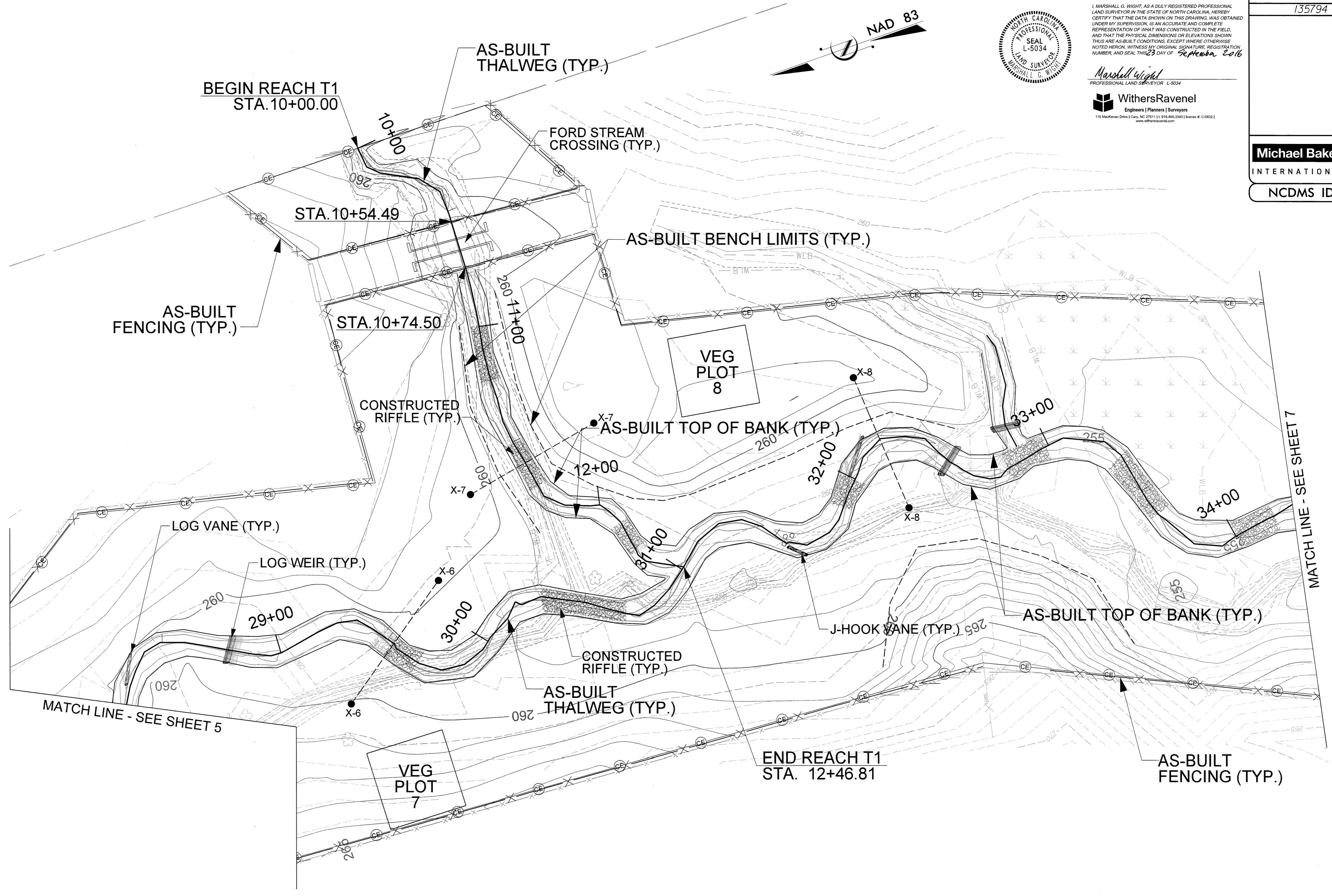
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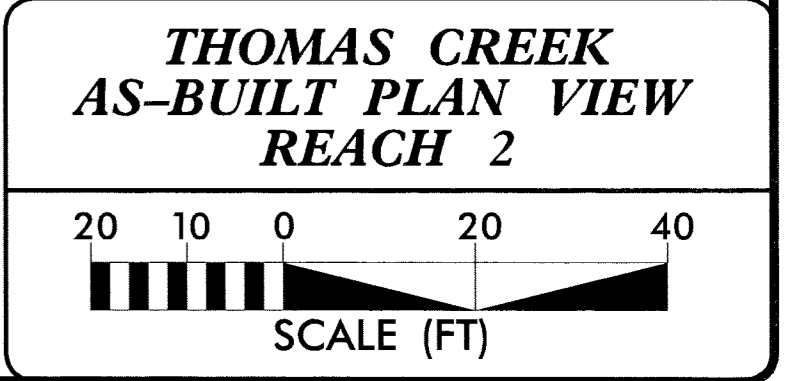
I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THEREIN ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23 DAY OF September 2016

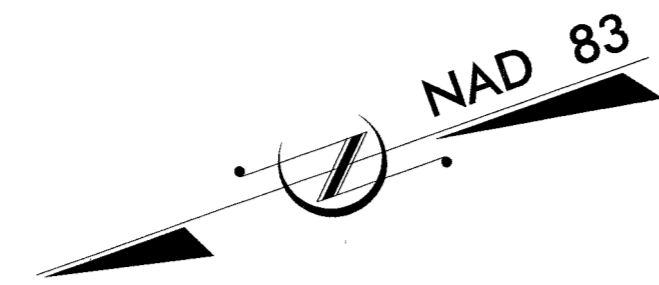
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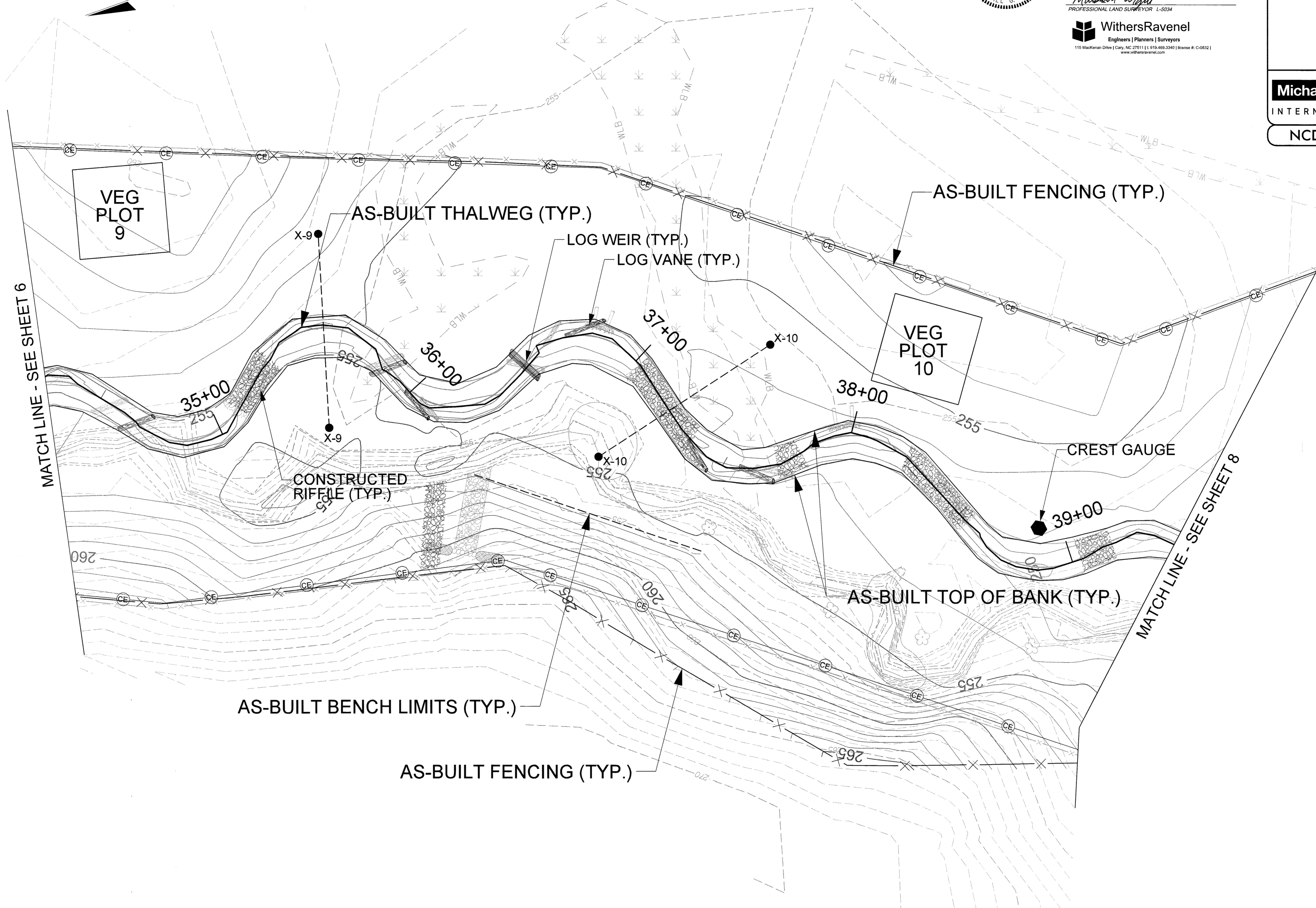


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Marshall G. Wight
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**THOMAS CREEK
AS-BUILT PLAN VIEW
REACH 2**

SCALE (FT)

2/26/2016

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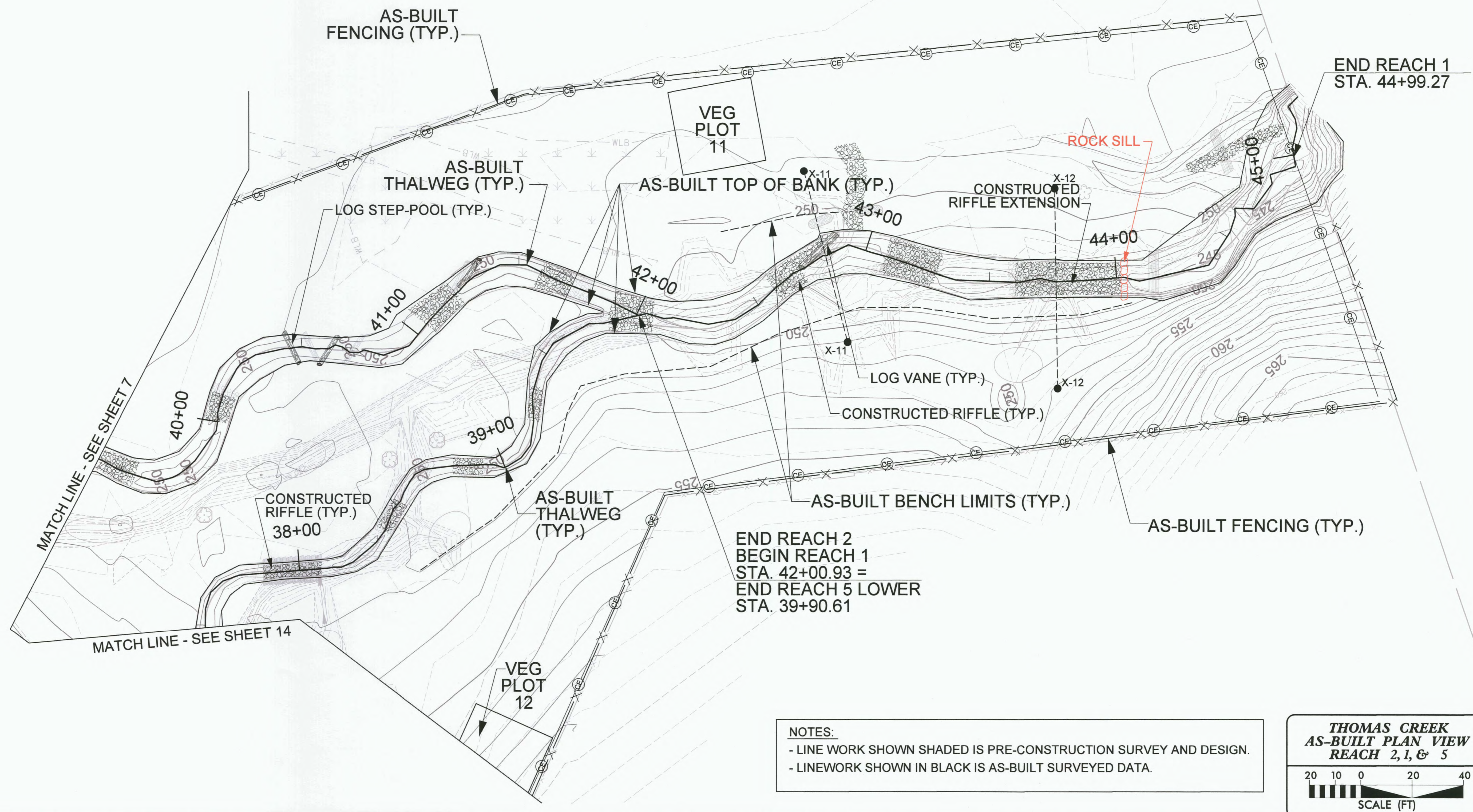
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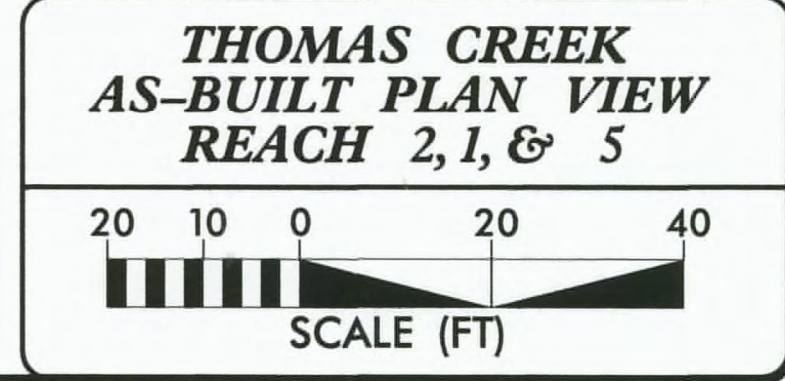
BAKER PROJECT REFERENCE NO. 135794 SHEET NO. 8

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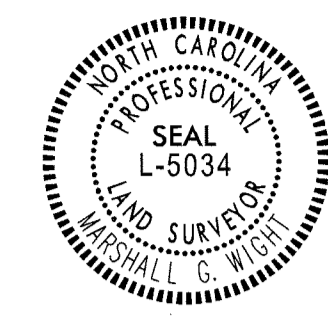
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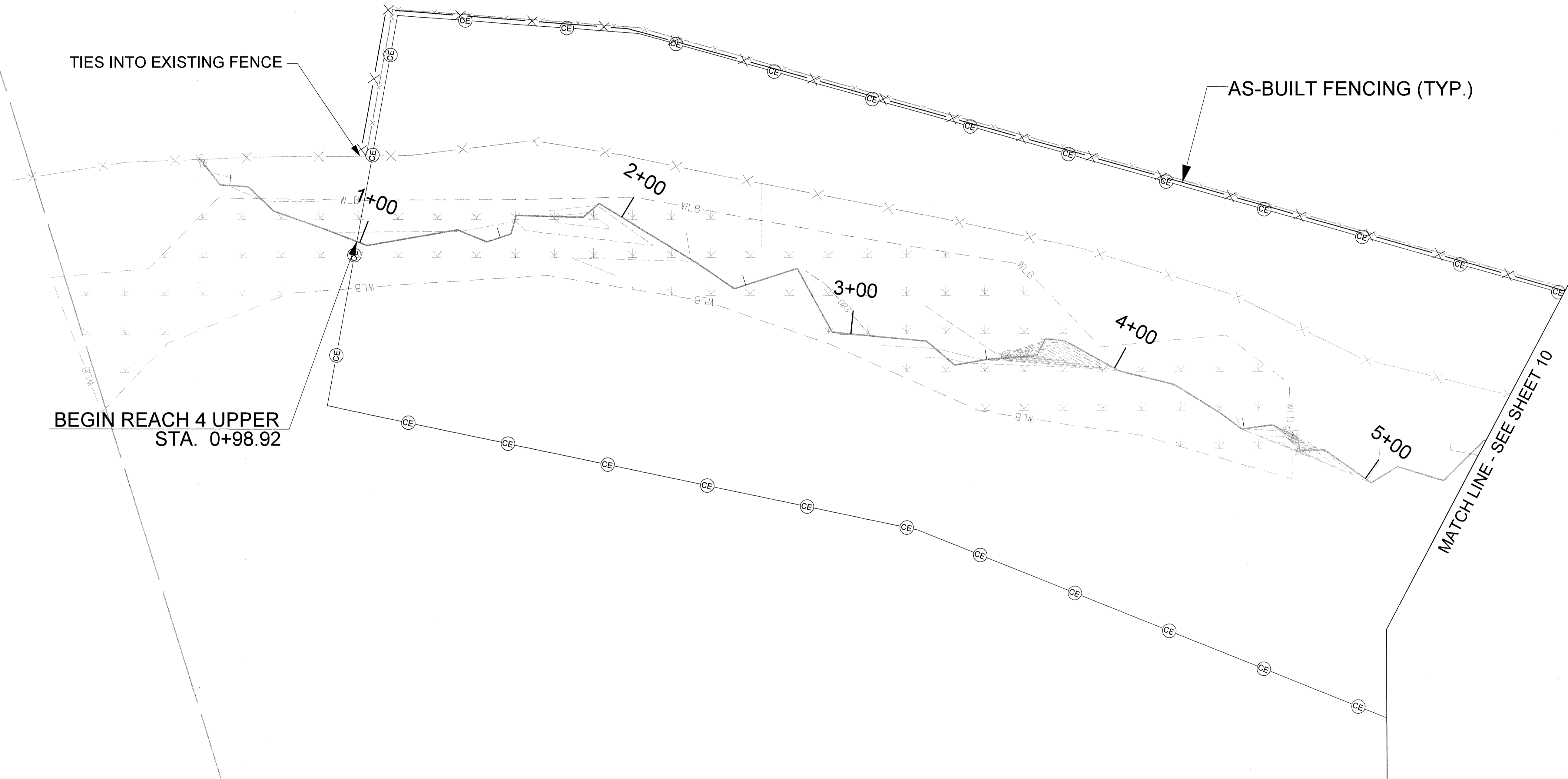
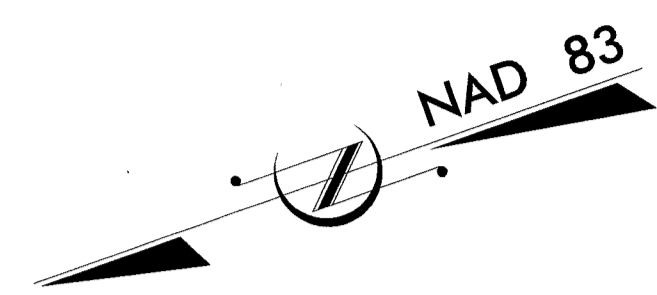
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135794	9
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**THOMAS CREEK
 AS-BUILT PLAN VIEW
 REACH 4**

SCALE (FT)

2/26/03

8/13/2016
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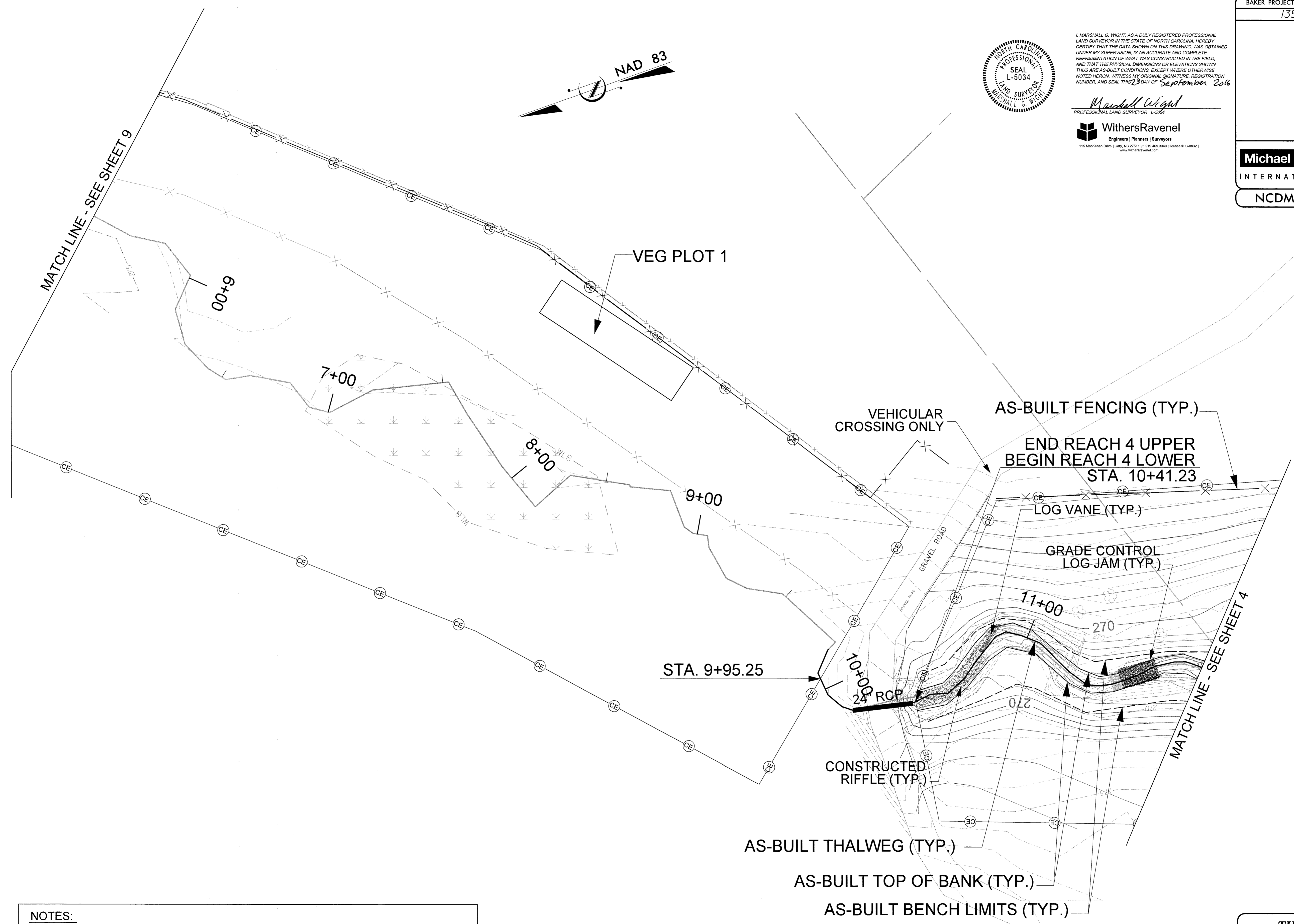
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**THOMAS CREEK
AS-BUILT PLAN VIEW
REACH 4**
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SCALE (FT)

2/26/03



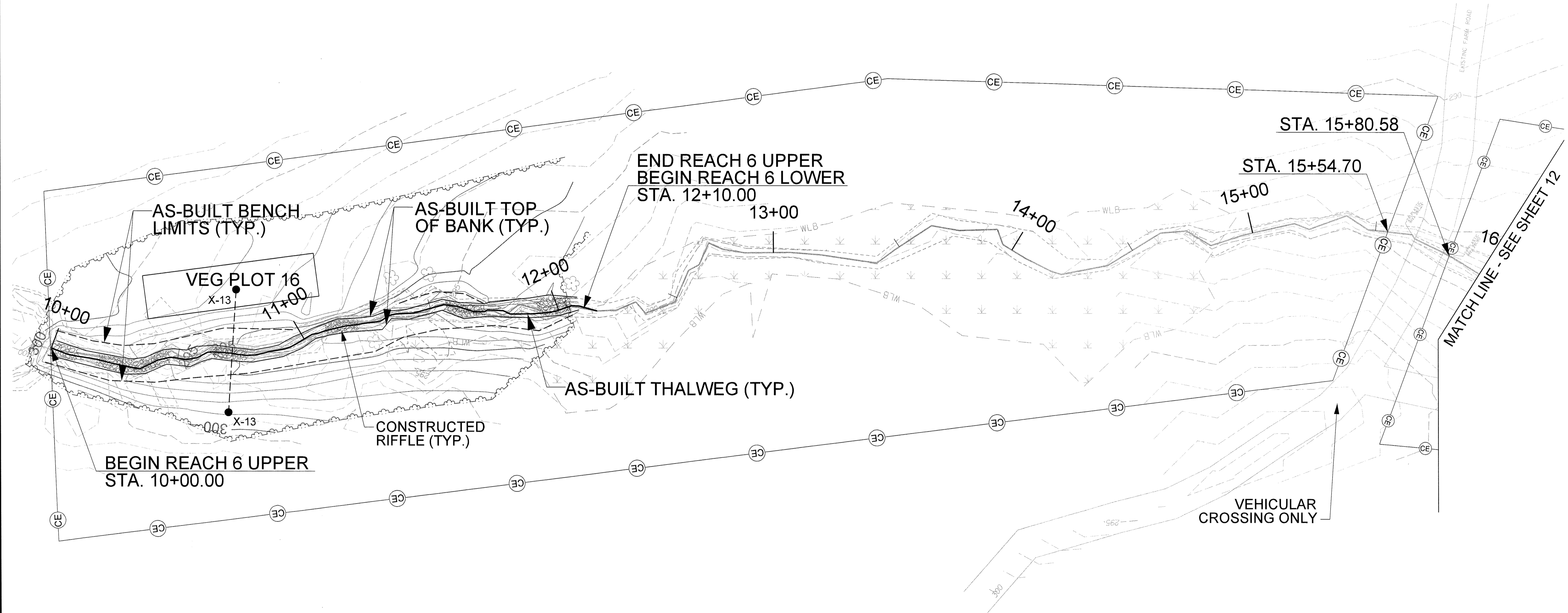
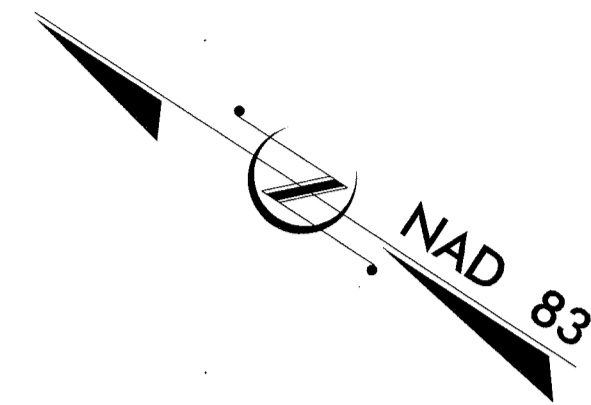
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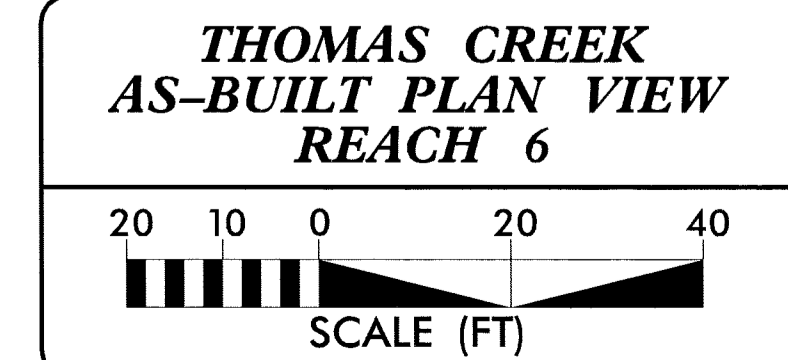
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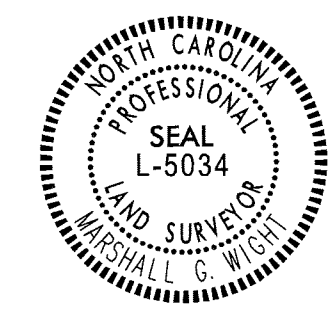


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BAKER PROJECT REFERENCE NO.	SHEET NO.
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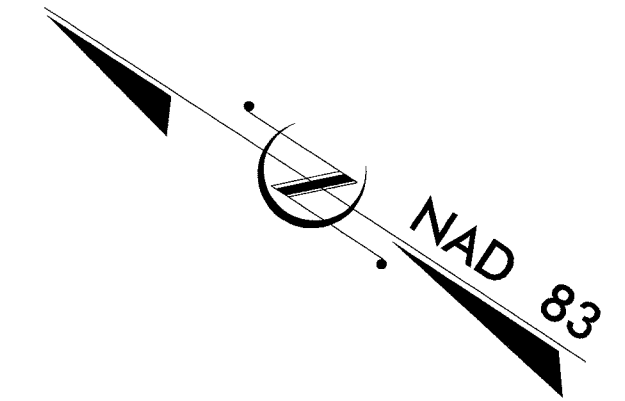
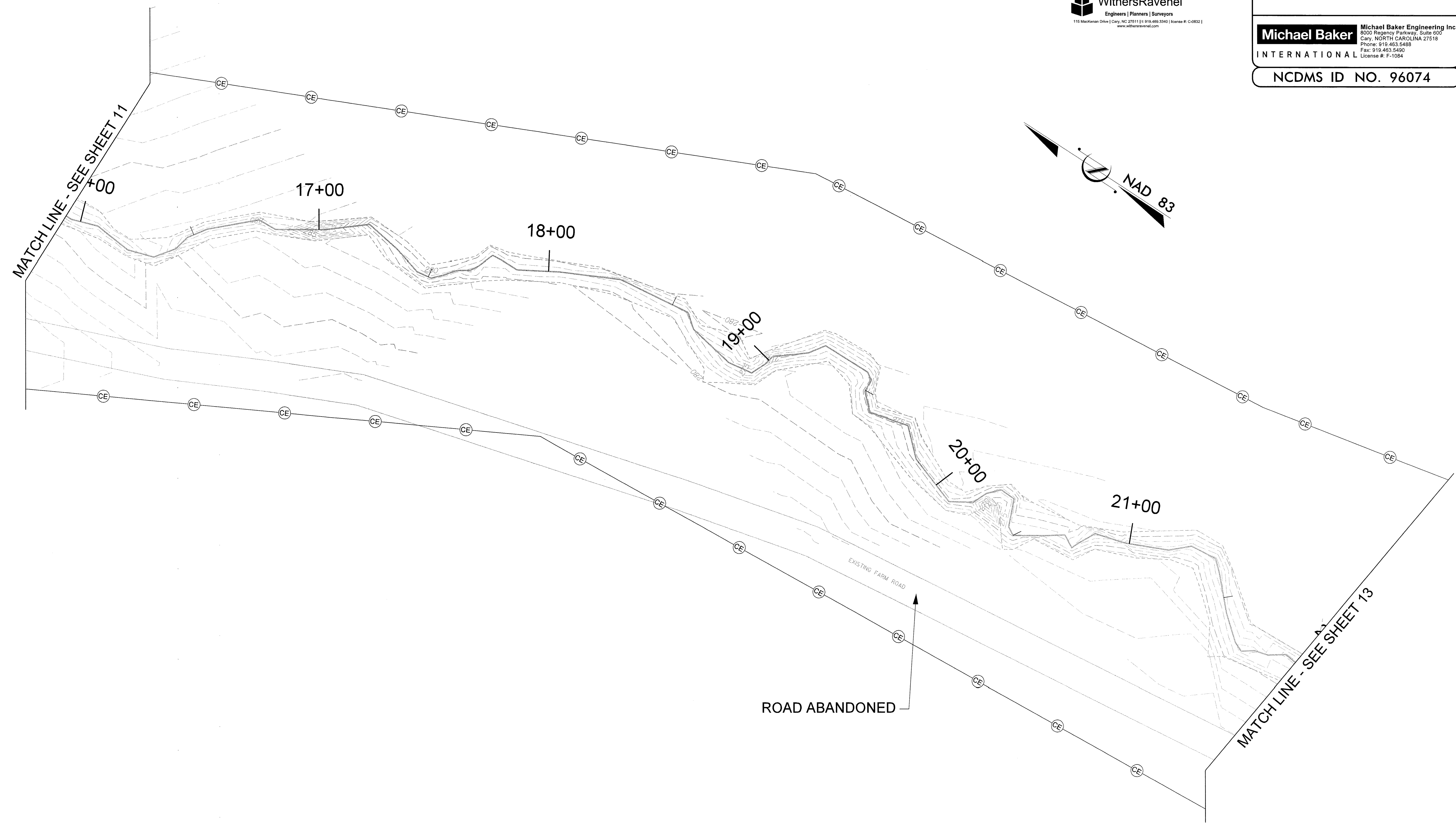


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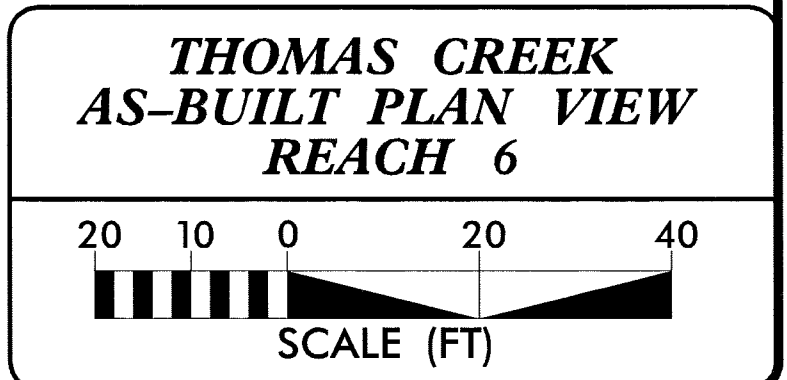
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 - LINE WORK SHOWN SHADED IS PRE-CONSTRUCTION SURVEY AND DESIGN.
 - LINEWORK SHOWN IN BLACK IS AS-BUILT SURVEYED DATA.



2/26/03

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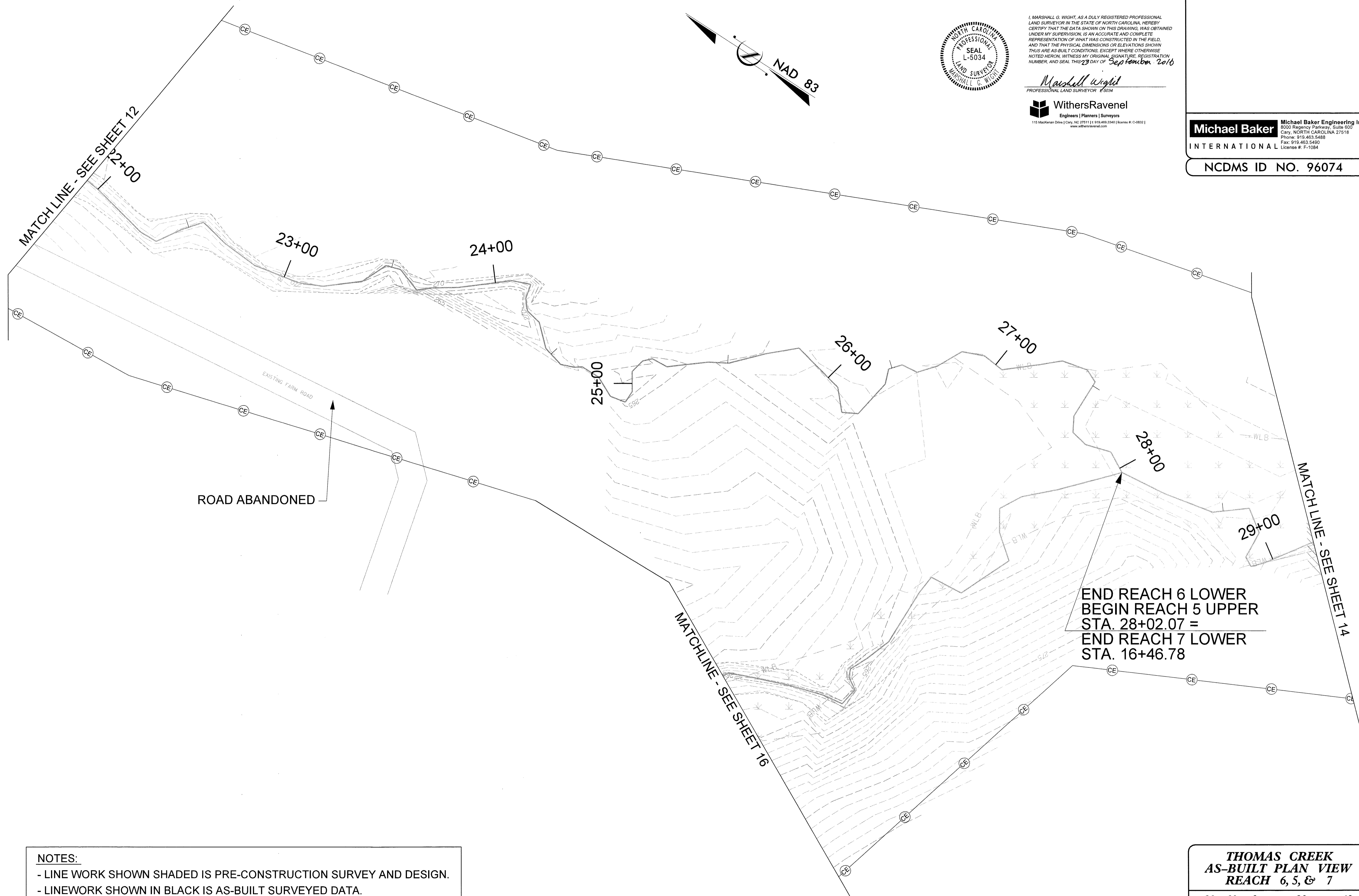
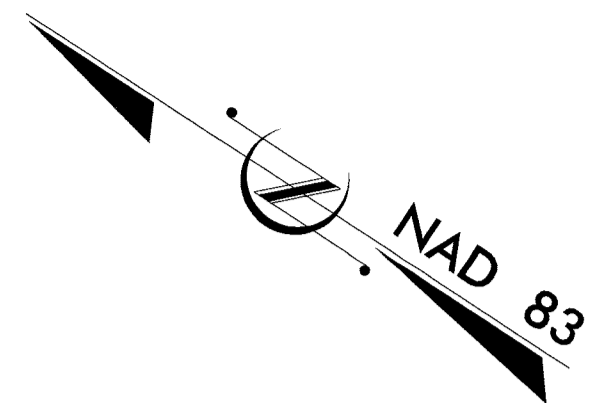
I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THIS ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 29 DAY OF September, 2016

Marshall Wight
PROFESSIONAL LAND SURVEYOR L-5034

WithersRavenel
Engineers | Planners | Surveyors
115 Mackinnon Drive | Cary, NC 27511 | (919) 485-2300 | License # C-0632 | www.wr.com

Michael Baker International Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.483.5488
Fax: 919.483.5490
License #: F-1084

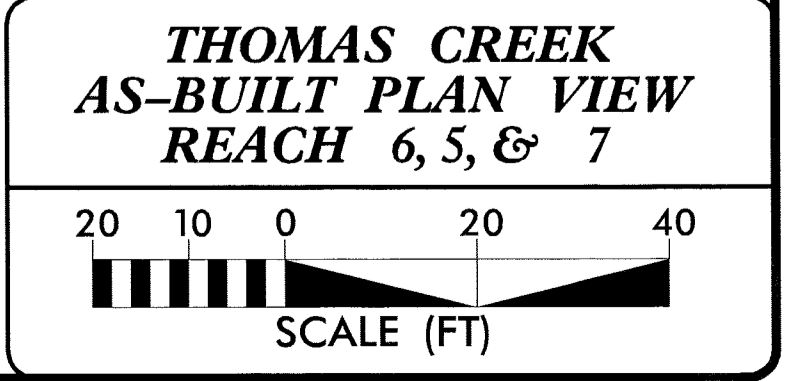
NCDMS ID NO. 96074



END REACH 6 LOWER
BEGIN REACH 5 UPPER
STA. 28+02.07 =
END REACH 7 LOWER
STA. 16+46.78

NOTES:

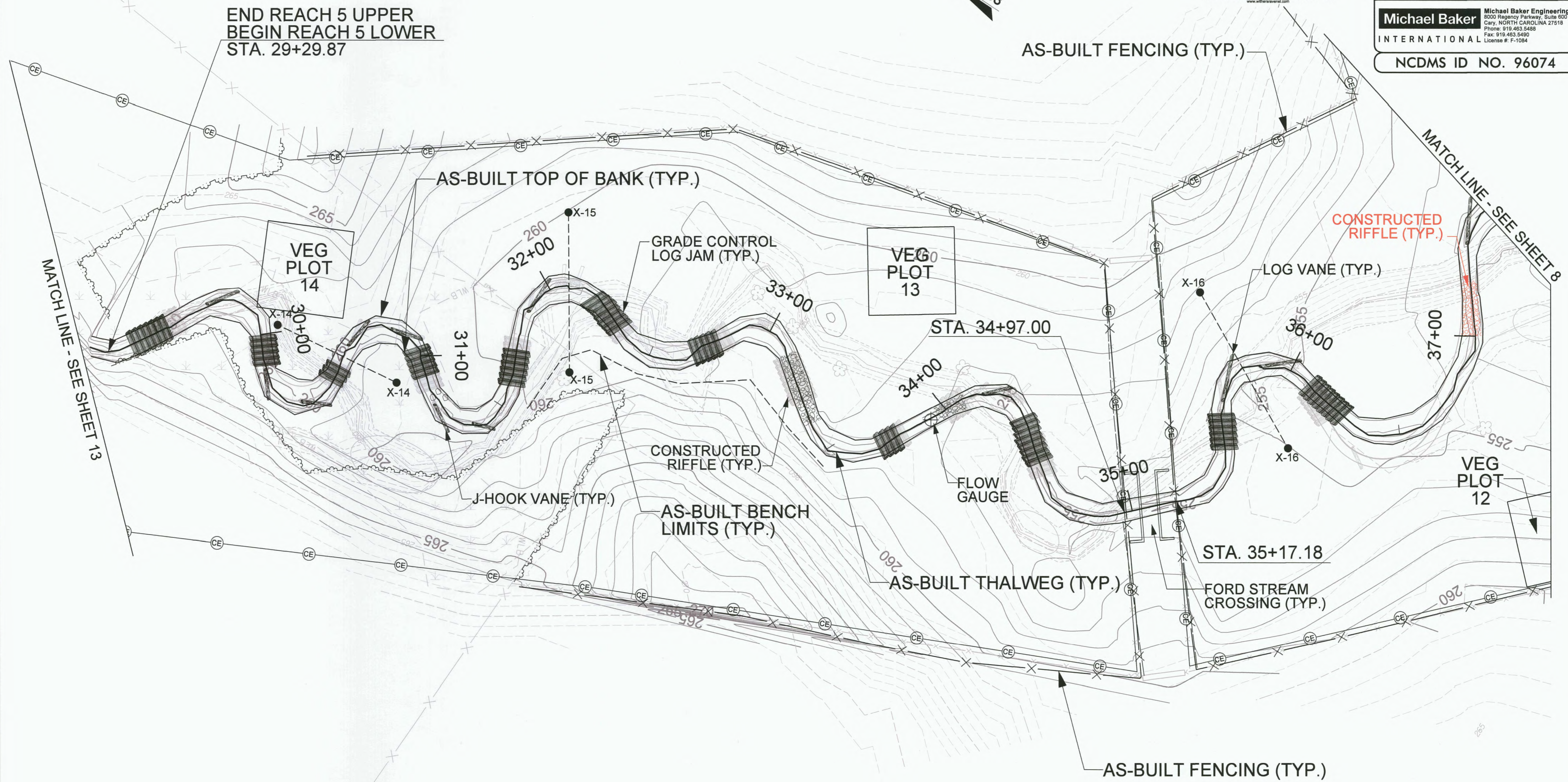
- LINE WORK SHOWN SHADED IS PRE-CONSTRUCTION SURVEY AND DESIGN.
- LINEWORK SHOWN IN BLACK IS AS-BUILT SURVEYED DATA.



2/26/03

9/13/2016
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BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 14
I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THEREON ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23 DAY OF September 2016.	
Marshall Wight PROFESSIONAL LAND SURVEYOR L-5034	
WithersRavenel Engineers Planners Surveyors 110 MacKinnon Drive Cary, NC 27511 919.488.3340 license #: C-0832 www.withersravenel.com	
Michael Baker International Michael Baker Engineering Inc. 3030 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.453.5488 Fax: 919.453.2490 License #: F-1084	
NCDMS ID NO. 96074	



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 - LINEWORK SHOWN IN BLACK IS AS-BUILT SURVEYED DATA.

**THOMAS CREEK
 AS-BUILT PLAN VIEW
 REACH 5**

SCALE (FT)

2/26/03

9/13/2016
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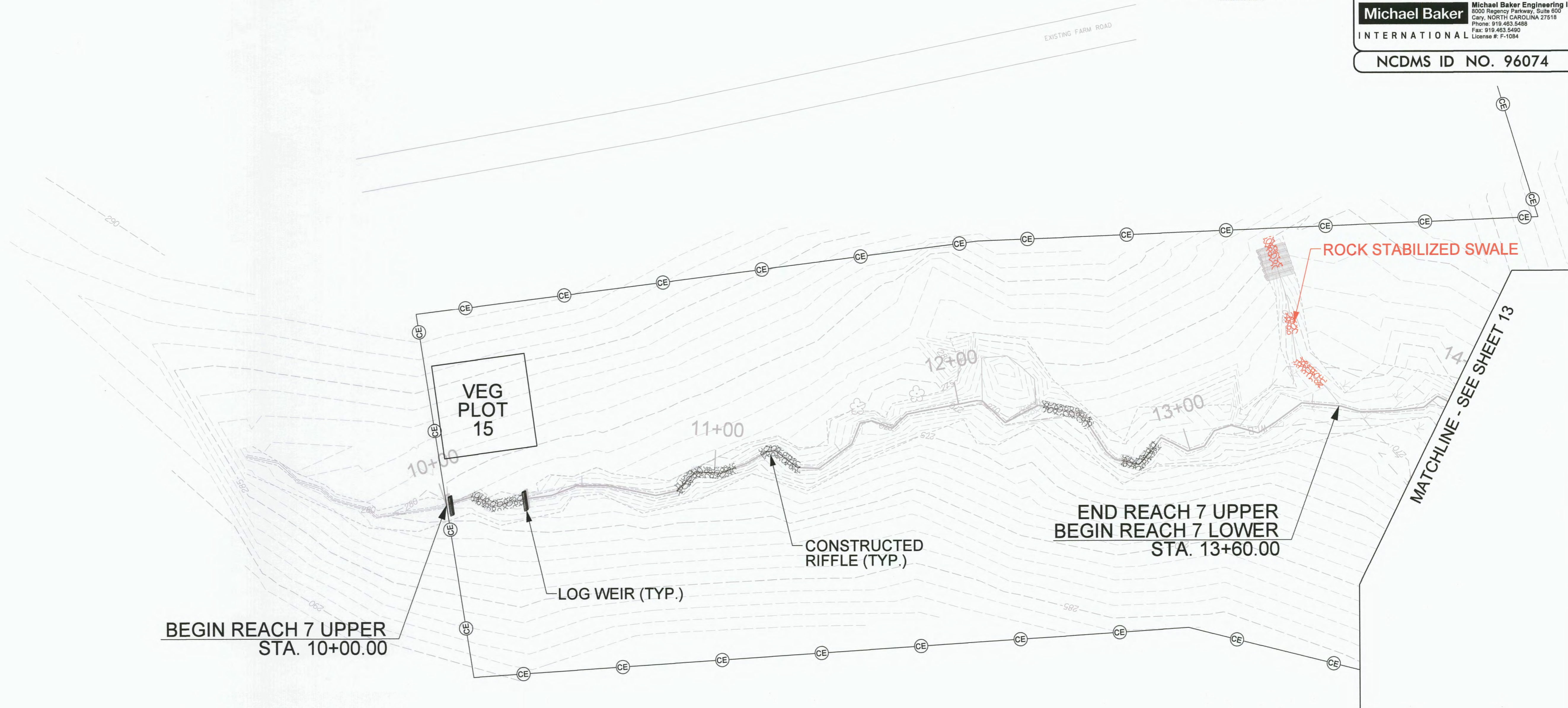


I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THERE ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23 DAY OF September 2016

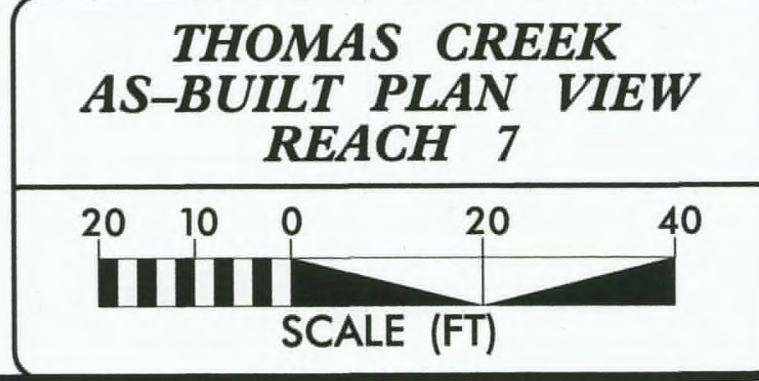
Marshall Wight
PROFESSIONAL LAND SURVEYOR L-5034

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Engineers | Planners | Surveyors
115 MacGowan Drive | Cary, NC 27511 | P: 919.463.3400 | License #: C-0892 | www.witnersravenel.com

BAKER PROJECT REFERENCE NO. 135794	SHEET NO. 15
Michael Baker International	
Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27519 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1084	
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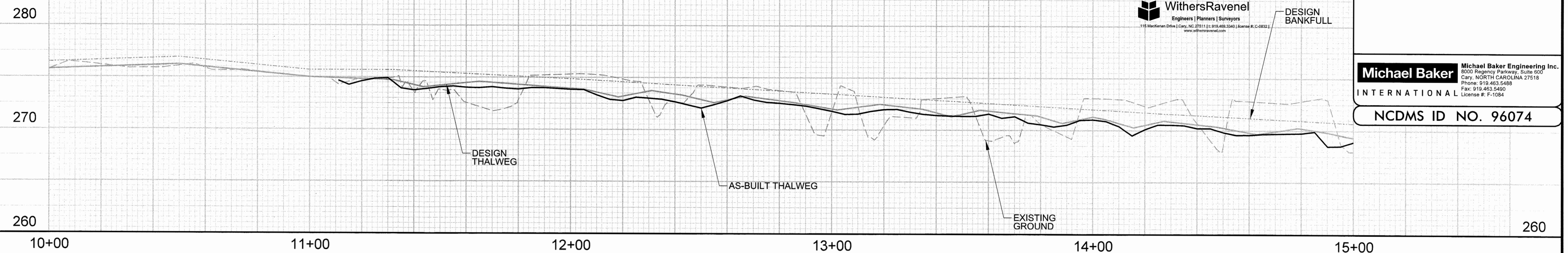
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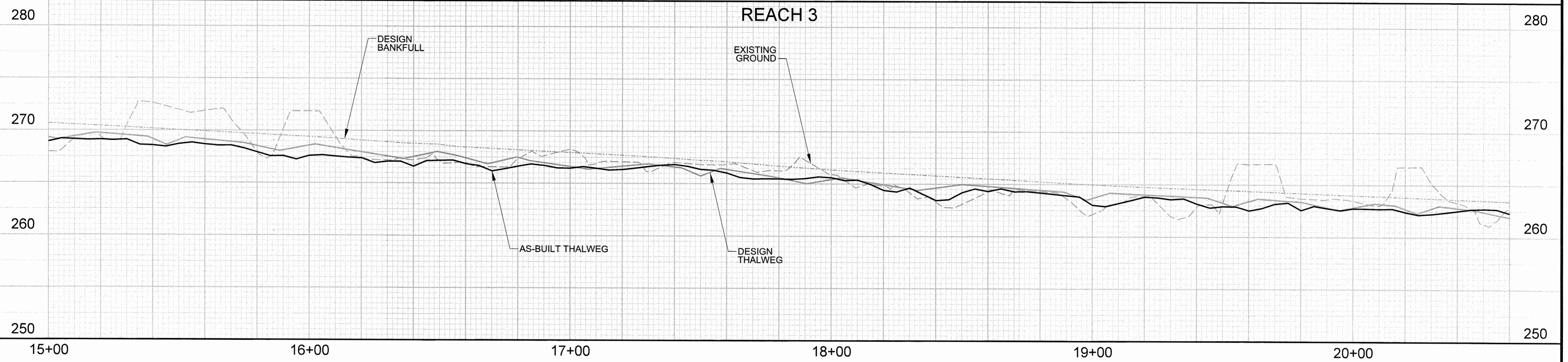
I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THIS ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23 DAY OF September 2016

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Engineers | Planners | Surveyors
110 Mackerran Drive | Cary, NC 27511 | (919) 469-5340 | (919) 463-5488
www.wr-engineers.com

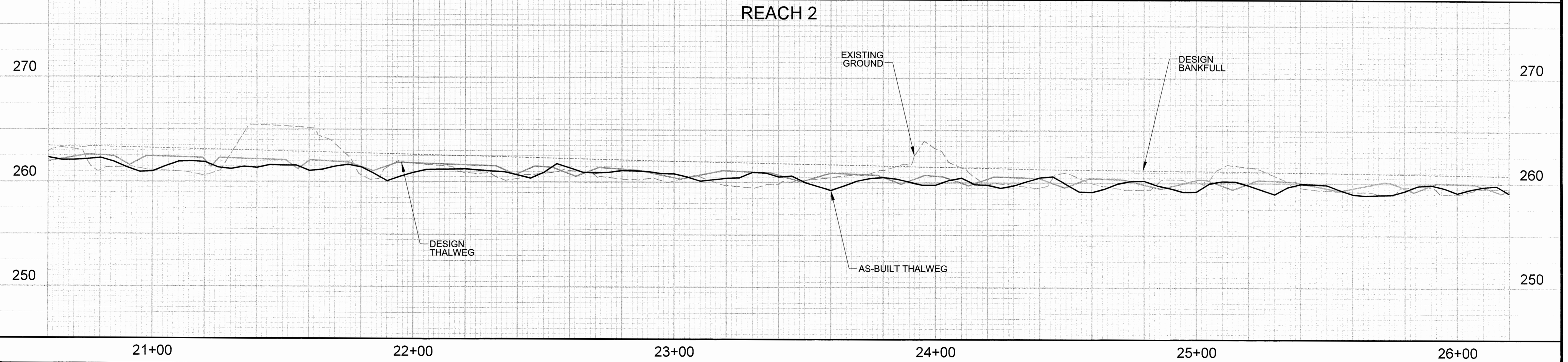
BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	16
Michael Baker International Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 600 Cary, NORTH CAROLINA 27518 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1094	
NCDMS ID NO. 96074	



REACH 3



REACH 2



9/13/2016
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2/26/03

REACH 2



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Marshall Wight
PROFESSIONAL LAND SURVEYOR - L-5034

WithersRavenel
Engineers | Planners | Surveyors
116 MacKean Drive | Cary, NC 27511 | 919.463.3342 | License #: C-6832
www.withersravenel.com

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	17

Michael Baker INTERNATIONAL	Michael Baker Engineering Inc. 8000 Regency Parkway, Suite 500 Cary, NORTH CAROLINA 27518 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1084
NCDMS ID NO. 96074	

270

260

250

250

27+00

28+00

29+00

30+00

31+00

REACH 2

270

260

250

270

260

250

EXISTING GROUND

DESIGN BANKFULL

DESIGN THALWEG

AS-BUILT THALWEG

31+00

32+00

33+00

34+00

35+00

36+00

REACH 2

260

250

240

260

250

240

DESIGN BANKFULL

AS-BUILT THALWEG

DESIGN THALWEG

EXISTING GROUND

37+00

38+00

39+00

40+00

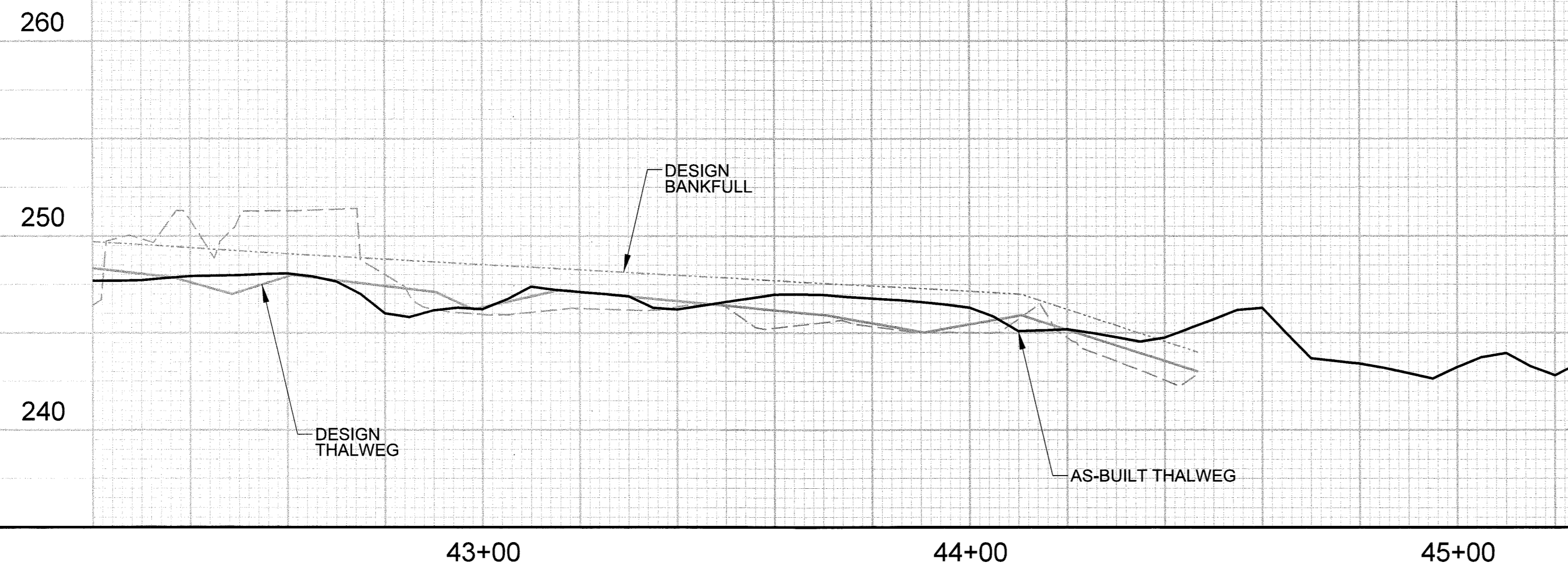
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REACH 1



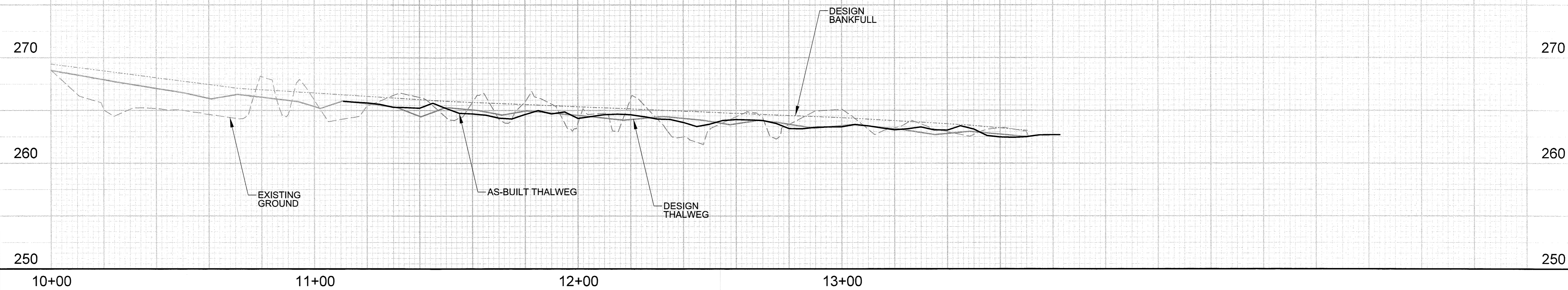
I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THEREIN ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23rd DAY OF September 2016

Marshall G. Wight
PROFESSIONAL LAND SURVEYOR L-5034

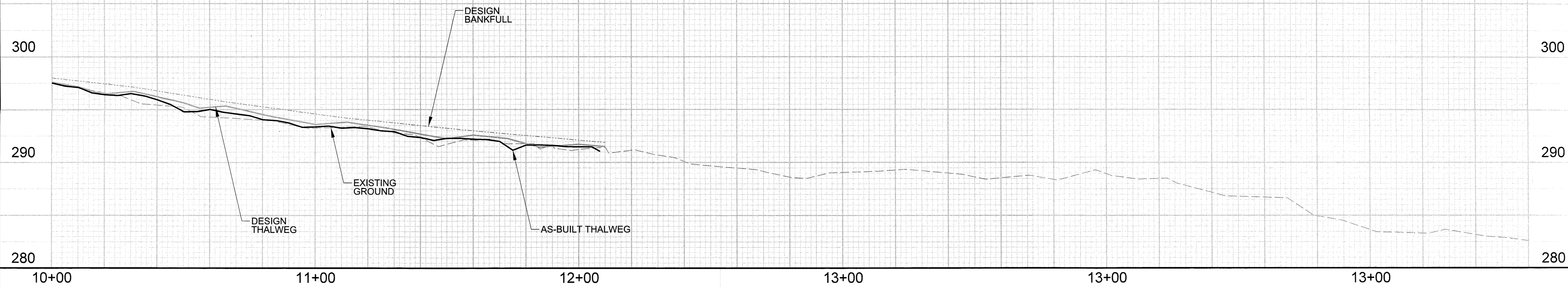
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	18
Michael Baker International	
Michael Baker Engineering Inc. 3000 Progress Parkway, Suite 500 Cary, NORTH CAROLINA 27518 Phone: 919.463.5488 Fax: 919.463.5490 License #: F-1084	
NCDMS ID NO. 96074	

REACH 4



REACH 6



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2/26/03

REACH 5

NCDMS ID NO. 96074

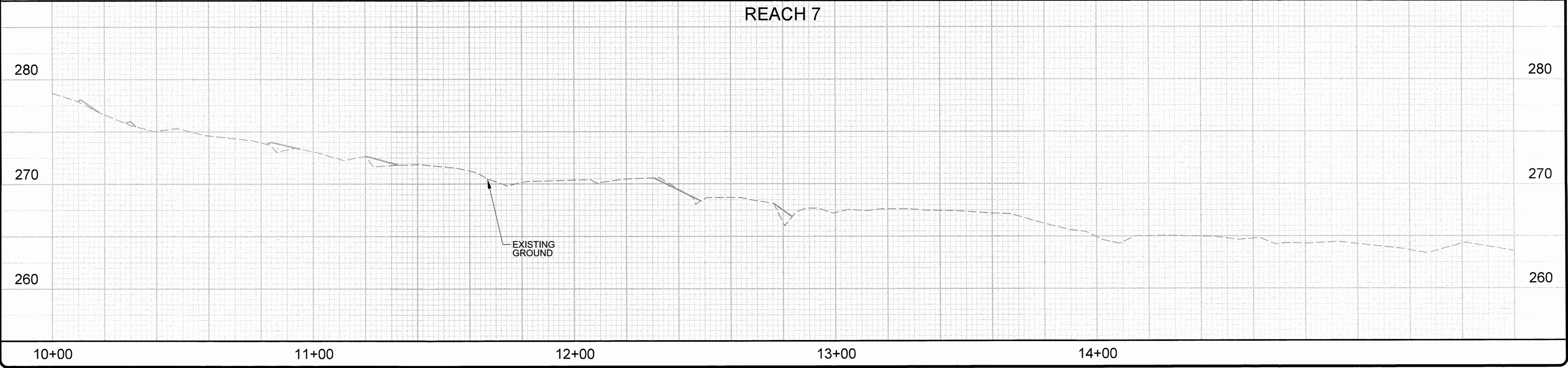
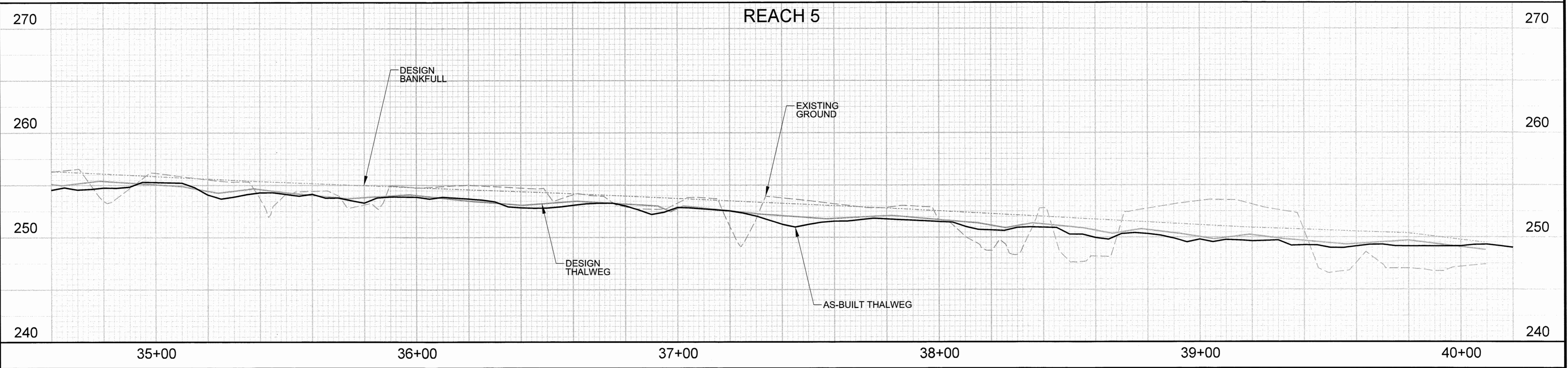
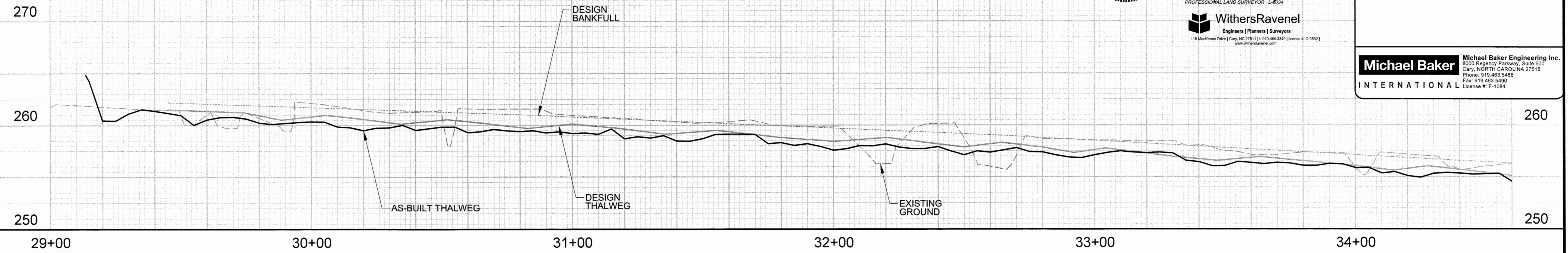
BAKER PROJECT REFERENCE NO. 135794 SHEET NO. 19



I, MARSHALL G. WIGHT, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THEREIN ARE AS-BUILT CONDITIONS, EXCEPT WHERE OTHERWISE NOTED HEREON, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 23RD DAY OF September 2016

Marshall G. Wight
PROFESSIONAL LAND SURVEYOR L-5034
WithersRavenel
Engineers | Planners | Surveyors
115 Mackerran Drive | Cary, NC 27511 | (919) 469-3340 | License #: C-0892
www.witnersravenel.com

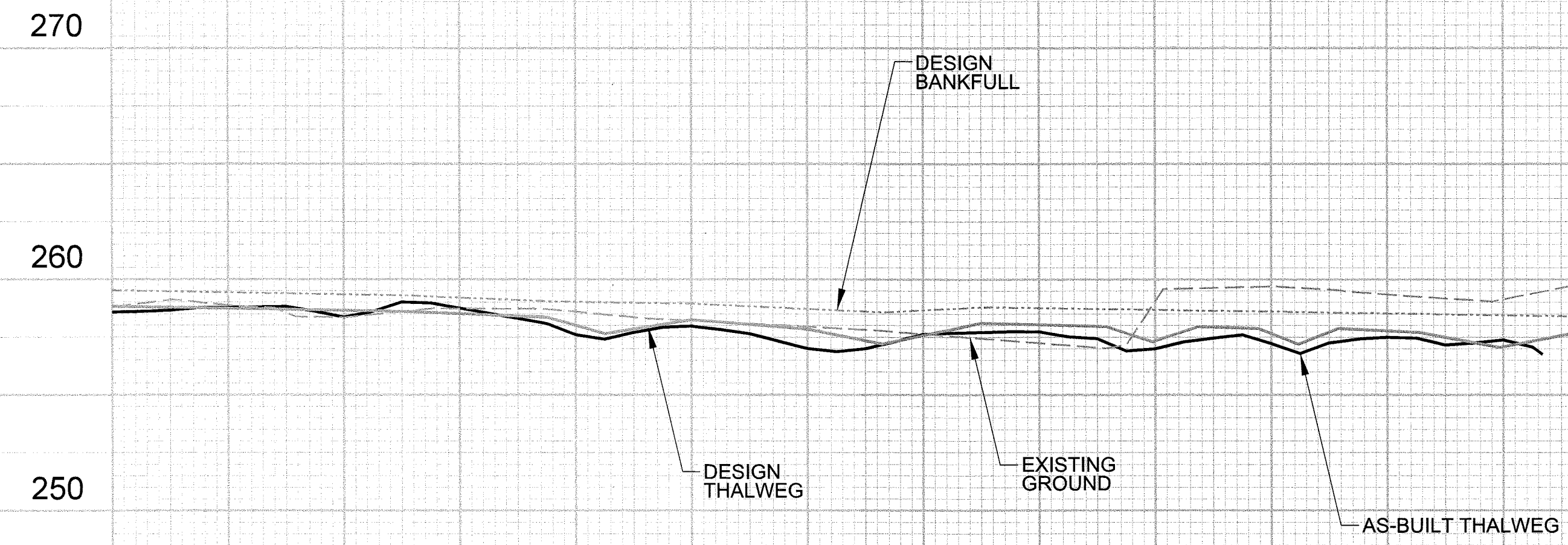
Michael Baker INTERNATIONAL
Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084



9/13/2016 10:57:10 AM ThomasCreekFD\Design\As-Built\Plans\135794_AB_PSH+PFL-19.dgn

2/26/03

REACH T1



10+00 11+00 12+00 13+00 14+00

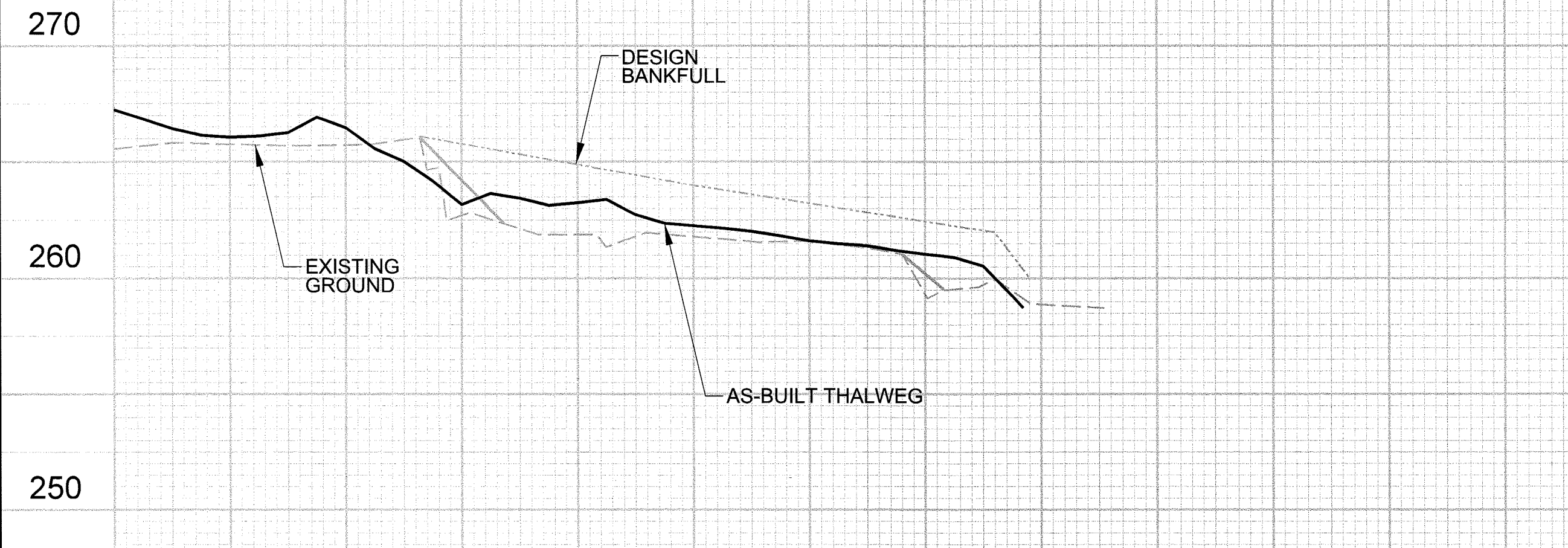


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Marshall Wight
PROFESSIONAL LAND SURVEYOR L-5034
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Engineers | Planners | Surveyors
115 MacKinnon Drive | Cary, NC 27511 | E: 919.493.3340 | F: 919.493.3321 | www.wr-engineers.com

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	20
Michael Baker Engineering Inc. INTERNATIONAL	
NCDMS ID NO. 96074	

REACH T2



10+00 11+00 12+00

8/15/2016 10:32:57 AM ThomasCreekFD\Design\As-Built\Plans\135794_AB-PSH-PFL-20.dgn

250

270

260

250

APPENDIX E

Photo Log



Reach 3, view upstream, Station 11+75



Reach 3, view downstream, Station 11+75



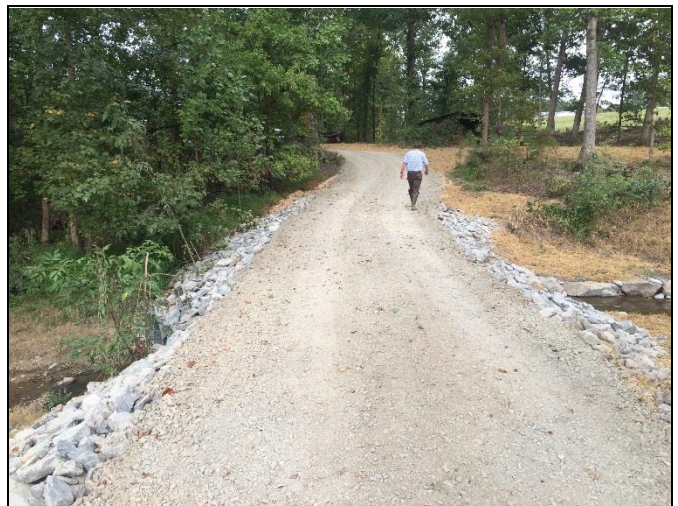
Reach 3, view upstream, Station 15+75



Reach 3, view downstream, Station 16+25



Reach 3, view downstream at pipe crossing, Station 18+50



Reach 3, stream crossing, Station 18+80



Reach 3, Station 19+00



Reach 4, view upstream at Station 2+50



Reach 4, view upstream at Station 5+90



Reach 4, view downstream at Station 5+90



Reach 4, view upstream at Station 10+10



Reach 4, view upstream at Station 10+50



Reach 4, view upstream at Station 11+75



Reach 4, view downstream at Station 12+25



Reach 4, view upstream at Station 13+00



Reach 2, view upstream at Station 20+60



Reach 2, Flow Gauge #1 at Station 20+75



Reach 2, view of stabilized drainage on left bank at Station 20+80



Reach 2, view upstream at Station 22+00



Reach 2, view upstream at Station 23+00



Reach 2, view upstream at Station 25+25



Reach 2, view downstream at Station 25+50



Reach 2, view of crossing at Station 27+75



Reach 2, view downstream at Station 30+20



Reach T1, view upstream at Station 11+75



Reach 2, view of drainage on left bank at Station 32+90



Reach 2, view downstream at Station 33+25



Reach 2, view downstream at Station 34+30



Reach 2, view downstream at Station 36+90



Reach 2, view upstream at Station 38+25



Reach 2, Crest Gauge at Station 38+75



Reach 2, view downstream at Station 39+40



Reach 2, view upstream at Station 41+50



Reach 1, view upstream at Station 42+75



Reach 1, view downstream at Station 43+25



Reach 1, view of drainage on left bank at Station 44+00



Reach 6, view upstream at Station 11+00



Reach 6, view upstream at Station 12+00



Reach 6, view upstream at Station 15+25



Reach 6, view upstream at Station 18+90



Reach 6, view upstream at Station 25+50



Reach 7, view upstream at Station 10+40



Reach 7, view of stabilized drainage at Station 13+50



Reach 7, view upstream at Station 15+00



Reach 5, view upstream at Station 30+25



Reach 5, view downstream at Station 30+75



Reach 5, view downstream at Station 31+40



Reach 5, view downstream at Station 32+50



Reach 5, view upstream at Station 33+10



Reach 5, view downstream at Station 33+75



Reach 5, Flow Gauge #2 at Station 33+90



Reach 5, Rock Crossing at Station 35+00



Reach 5, view upstream at Station 36+40



Reach 5, view upstream at Station 36+75



Reach 5, view downstream at Station 37+30



Reach 5, view upstream at Station 38+50



Reach 5, view upstream at Station 39+90
(the confluence of R5 and R2)

